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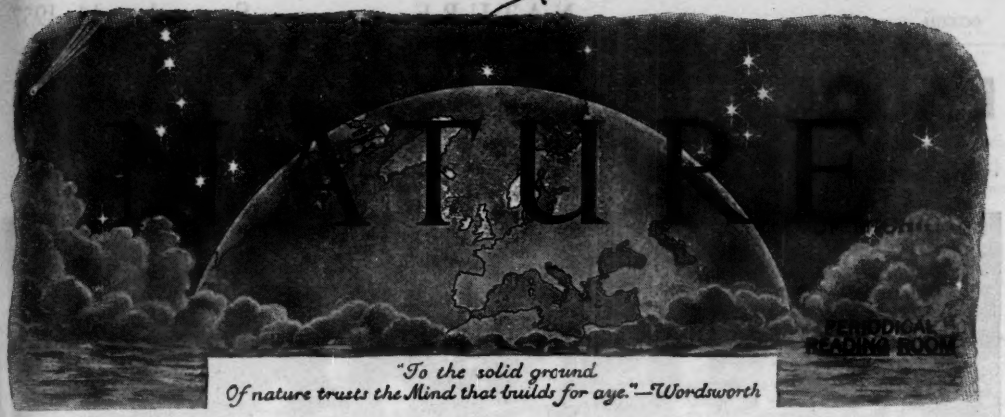

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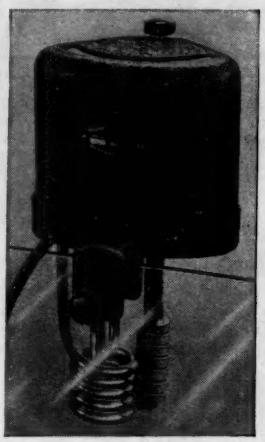

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AGENTS THROUGHOUT THE WORLD

NATURE

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BRITISH PUBLIC SCHOOLS AND THE FUTURE

DISCUSSION about the future of the British public schools cannot be confined to educational principles alone. This has been well brought out in recent months when new books, broadcasts and public lectures have shown that some of those who wish to see the public schools survive are as capable of radiating as much heat without light as those whose professed aim is to abolish the public schools as quickly as possible. This is not difficult to understand. The public school is a peculiarly British institution that is the envy of other countries which do not understand it and the despair of many British people who maintain that, as at present constituted, public schools have no place in a democracy but recognize that they have made an immeasurable contribution to the British way of life by the quality of education they provide.

As Vivian Ogilvie has shown, the story of the public schools is a baffling one[1]. The term 'public school' came into use about the beginning of the eighteenth century and was reserved for some of the best-known grammar schools like Eton, Winchester, Canterbury, Rugby and Harrow. A hundred years ago the Public Schools Commission recognized only nine schools. To the Fleming Committee a 'public school' denoted any school in membership of the Governing Bodies' Association or of the Headmasters' Conference; there are now nearly two hundred such schools[2]. Of these, about half are independent and the others are aided either by grants from the Ministry of Education or by local education authorities. Thus about a half the public schools secure aid from public funds and about a half are predominantly day schools.

To the majority of people, however, the public schools are the independent boarding schools and it is these schools which cause greatest controversy. 'Abolitionists' believe that if the independent boarding schools could be satisfactorily integrated into the national educational system, the direct-grant, aided and maintained schools would present no great problems; nor would the independent day schools. The knowledgeable abolitionist, however, is well aware that the best English public schools are among the finest of educational institutions, and to destroy them would be a piece of incalculable educational folly to the country and the world.

The reasons why parents sent their sons to public schools at the beginning of the nineteenth century are not very different from the reasons why parents send their sons to-day. These were clearly defined by the headmaster of Eton College, Mr. Robert Birley, in a public lecture organized as one of a series by the Director of the Institute of Education, University of Sheffield[3].

Parents send their sons to public schools mainly for three reasons. They are genuinely prepared to make considerable financial sacrifices so that their sons may attend a good school to receive a well-balanced education. Since they are prepared to make these sacrifices, they prefer their sons to attend boarding schools which will best prepare their sons for life in society. Even the opponents of public schools are prepared to concede that these are genuine educational reasons which merit respect and support. The third reason cannot be regarded as strictly educational and is the one which public school supporters find it more difficult to justify; many parents strongly defend the public schools not only on grounds of sentiment, but also because they are well aware that membership of them conveys social advantages which will help their sons in later life.

That many public schools provide a good education few would deny; they have done much to set and raise educational standards. Despite much nonsense talked about religion in the public schools, for example, the school chapel has done much for the development of character in many boys. In secular education, public schools have benefited by attracting staffs of quality; in the nineteenth century the assistant master at a public school was a person of considerable status in society, was adequately paid and, academically, often of the stature of a Fellow of a College. To-day, public schools still attract better masters than the grammar schools; higher salaries and smaller classes are great incentives. Often the standards set by the public schools have served to raise the standards of grammar and other secondary schools; this influence still exists. Decline of the public schools would almost certainly lead to a decline in standards at schools in the national educational system.

The existence of public schools can be justified by the contribution its scholars make to life and society. Whether leadership owes its origins mostly to genetics or the dicta of well-known military commanders is debatable; that most public school boys have poise and self-confidence is well known. Living together in school enables many public schoolboys to move with grace and distinction in many walks of life. This is a quality which is not so abundant among our young men that we can afford to obliterate it by doing away with our boarding schools without adequate reasons for so doing.

The third demand which parents make on the public schools is impossible to justify on educational grounds and has social, political and moral implications. Many parents—and they may be more than the headmaster of Eton would have us believe—send their sons to public schools because membership of these schools will be of service to them in their future careers. Although this charge may be exaggerated—the full effects of the establishment of grammar schools under the Education Act of 1902 have not yet been seen—the public school system undoubtedly confers advantages on its products which are denied to those

from State schools. A system which enables less able men to come to the top and prevents the abler from so doing cannot be justified on human, economic or moral grounds.

But even this does not provide a case for abolishing schools which have so much to commend them educationally; if the wrong boys are getting into public schools, other means of selecting them must be found. At present the main criterion for getting into a public school is the ability of parents to pay the fees demanded. Despite improved standards of the Common Entrance examinations, few cases are known of boys failing to get into public schools of the parents' choice provided the parents can pay their fees and have certain associations with the schools. There are some, like the High Master of St. Paul's School, who is prepared to defend the parent's right to spend his money in buying a public school education for his son[4]. Thoughtful supporters of the public schools recognize that few parents can afford that privilege and have queazy consciences about a system which confers marked educational and social advantages on boys who may have little merit in them.

The difficulty, of course, is to find a system of selection which would throw the public schools open to all. Many in the public schools are anxious to enlarge their areas of recruitment because they are convinced that their schools have something of value to offer to individual boys and to the educational system as a whole. These headmasters, and others, showed their readiness to accept the main proposals of the Fleming Report; these proposals need to be re-examined. Under both the two main proposals put forward by the Fleming Committee, the general effect would be to reserve some places in public schools for scholars whose parents would be unable to pay the high fees demanded. By a Government decision in 1946, the responsibility for paying fees for selected scholars would devolve upon the local education authorities. There is little doubt that this Government decision was hopelessly impractical and, during the deliberations of the Fleming Committee, was opposed by every representative of local education authorities. It is not surprising, therefore, that with few exceptions, local education authorities have done nothing to carry out the Fleming proposals. To spend £400 per annum on sending a boy to a public school with which the local authority has no affiliations is asking a great deal of that authority; one-tenth of that sum is sufficient to send the boy to the local grammar school of which the authority is so rightly proud. Experience since 1946 has shown that, if boys whose parents have limited means are to be admitted to public schools, their fees will have to be paid directly by the Treasury.

To dismiss this proposal as beyond the country's financial resources invites comparison with the introduction of compulsory education for all in 1870 or the establishment of new universities over the past seventy years. To the argument that the State would not be justified in spending so much on individual boys comes the answer that the number of boys being given 'free' places at universities is still increasing. To begin with, a small number of places at public schools could be reserved for 'free-place' scholars whose fees would be paid direct by the Treasury; the numbers could be steadily increased until the number of 'free-place' scholars exceeded the number of fee-paying scholars. Such a proposal will undoubtedly be greeted with horror by those who wish to see the public schools carry on as they have always done. The more long-sighted supporters of the public schools will see that, owing to certain trends in contemporary society, proposals of this kind represent the public schools' main hope of survival. It should be borne in mind that fee-paying scholars are likely to get even more from their boarding school education if a considerable number of their colleagues come from walks of life very different from their own.

Means of administering such a scheme could, in principle, follow the proposals set out in the Fleming Report, which recommended the appointment of a central advisory committee responsible to the Minister of Education and the members of which would include representatives of local education authorities, governing bodies of public schools and the teaching professions, with other persons not connected with the conduct or administration of education.

There remains the cardinal problem of selection. If financial aid were made available by the Treasury, what method of selection should be adopted to bring the most suitable boys to the public schools? More difficult still, what kind of boys would be selected? To which schools should boys be sent? No easy solutions to these questions are likely to be found, as was indicated in a recent broadcast discussion between C. A. R. Crosland and Sir John Wolfenden[5]. To fail to make the attempt, however, would be unjust both to those individuals likely to profit by a public school education, to the schools themselves and to the national education system.

The selection of schools to which boys would be sent should present no great difficulty. Schools should be allowed to participate only if they wished to do so and if their academic standing and reputation were such that the expenditure of public moneys on 'free-place' scholars could be justified; according to Ogilvie there are between sixty and seventy such schools. Common Entrance examinations standards for *all* boys wishing to enter these schools might have to be raised. Those schools of lesser quality which cater mainly for boys of limited intellectual ability but whose parents have ample means or are prepared to make sacrifices in order to buy their sons a place in society should not be allowed to participate in any new arrangements. The increasing number of grammar school boys who proceed to the universities is likely to cause the lesser public schools to wither away with no great loss to the boys who attend them, or to the nation.

What qualities would be looked for in boys selected to attend outstanding public schools as non-fee-paying scholars? The simplest criterion would be

that of intellect; this would be the most easy to discern. To produce a form of Platonic institution, however, where all the best brains were gathered together, would be undesirable both for the boys and for the national educational system as a whole. Much more desirable would be the selection of those qualities of character similar to those looked for in Rhodes Scholars who proceed to Oxford from Commonwealth countries and the United States. These Scholars have good intellects but are not necessarily outstanding on this count alone; much more attention is given to their ability to mix with their fellowmen and their desire and aptitude to serve them. The criticism could fairly be made that by this method an élite community would still be created at the public schools. These boys would differ in one important respect from the élite which attend the public schools to-day; they would be deliberately chosen and not owe their positions in school to their parents' wealth.

Critics would say that it is impossible to discover these qualities in boys of thirteen. The same critics were uncompromising in their opposition to the use of group selection methods for discovering potential officers in the Army during the early years of the Second World War. The contributions of Colonel J. R. Pinsent and his War Office Selection Boards in making the best use of man-power is now accepted as one of the most important educational and social discoveries of the War. The other Services were not slow in following Pinsent's lead, while a recent report of the Civil Service Commissioners has shown how group selection methods can be used in the selection of candidates for important positions in the Civil Service[6]. These methods are being increasingly used in industry for the selection of potential executives. Similar methods could be devised to select suitable candidates for public school places.

Experience already gained at Service institutions with public-school status like Dartmouth, Sandhurst, Welbeck and Cranwell would be of use in helping to formulate the selection methods. The use of group selection procedures would be an extension of the proposal put forward by the Fleming Committee for the setting up of regional interviewing boards.

Besides non-fee-paying scholars recruited in this way, room might have to be found for other groups of boys. There are those from geographical areas where opportunities for receiving education worthy of their intellectual level are few or non-existent; these boys from rural areas deserve the most sympathetic consideration. A case could be made out for boys from broken homes, but it is difficult to justify the high expenditure involved; it might also, as Sir John Wolfenden has suggested, lead to more frying pans being thrown on Friday nights. A better case could be made out for able boys who come from homes where the parents are hostile to the further education of sons who will soon be bread-winners, or because of peculiar difficulty caused by the nature of the father's occupation.

Schemes for sending poor boys to public schools are, of course, fraught with other difficulties. There is the danger that chosen boys will not fit into the social life of the school, or will become misfits in their families. This is a danger which besets any boy who moves into a different educational level from that of his parents; it is doubly dangerous when he moves into an obviously different social stratum. Experience already gathered at several public schools which have taken non-fee-paying scholars—Mill Hill has taken considerable numbers—shows that, with wise guidance from headmasters and housemasters, this danger can be overcome.

There is also the danger to the grammar schools. A policy of systematically 'creaming off' able boys to be sent to public schools could deprive the grammar schools of promising material and lead to the debasing of their own standards. This danger may be more apparent than real. In Britain as a whole there are still insufficient grammar school places for all boys who could profit by them; the number of boys who could be accommodated in the sixty or seventy public schools would represent a small fraction of the total available in the country at any one time.

What is now needed is a new look at the place of the public schools in the general educational system and the life of the nation. The Minister of Education should invite his central advisory councils for education to re-investigate the proposals contained in the Fleming Report or appoint a working party to see how far these and other proposals it recommends are practicable in the next few years. These deliberations should be carried out in a national atmosphere free from the polemics of those who cry "hands off the public schools!" or from partisan statements contained in documents like the Labour Party's "Challenge to Britain". Those responsible for administering the more important public schools are aware that there is a growing and irresistible trend towards greater equality in society. They realize that, unless they can find a means of opening their doors to a greater range of scholars from all social classes, they may find them shut by political action. They recognize that a society divided by educational institutions, the main criterion of which for entry is money, is unlikely to be acceptable much longer in Great Britain.

As the leaders of the main political parties are themselves products of the more important public schools, it is to be hoped that they can persuade their followers to discuss the future of the public schools in a spirit of goodwill where the only consideration is how they can best serve the interests of the individuals and the nation. Despite their anomalous position in the British educational system, to lose them would be a national disaster. As Sir John Wolfenden has well written[7], public schools "embody an immense heritage of accumulated experience. They have in the past shown themselves capable of evolutionary change. There is every reason to expect that, again in the twentieth century, they will be capable of meeting the new requirements of a new social and economic situation and of making a yet wider and deeper contribution to the national life than they have done in the past".

No mention has been made of public schools for girls or of independent preparatory schools. They would have to be considered in the light of developments inside public schools for boys.

[1] Ogilvie, Vivian, "The English Public School" (Batsford, 1957).
[2] "The Public Schools and the General Educational System" (H.M.S.O., 1944).
[3] The Future of the Independent Schools. Occasional Publication No. 3 (University of Sheffield, June 1957).
[4] Gilkes, A. N. G., "Independent Education: In Defence of Public Schools" (Gollancz, 1957).
[5] B.B.C. Home Service (July 28).
[6] Recruitment for the Administrative Class of the Civil Service and Senior Branch of the Foreign Service (H.M.S.O., July 30, 1957).
[7] "The Public Schools Today" (University of London Press, 1948).

INSTINCTIVE BEHAVIOUR IN ANIMALS AND MEN

l'Instinct dans le Comportement des Animaux et de l'Homme

Par M. Autuori, M.-P. Bénassy, J. Benoit, R. Courrier, Ed.-Ph. Deleurance, M. Fontane, K. von Frisch, R. Gesell, P.-P. Grassé, J. B. S. Haldane, Mrs. Haldane-Spurway, H. Hediger, M. Klein, O. Koehler, D. Lehrman, K. Lorenz, D. Morris, H. Piéron, C.-P. Richter, R. Ruyer, T.-C. Schneirla, et G. Viaud. Pp. iv+796. (Paris: Masson et Cie, 1956.) Broché, 6,500 francs; Cartonné toile, 7,200 francs.

THIS book consists of the papers, complete with illustrations and subsequent discussions, delivered at a symposium entitled "Instinct in the Behaviour of Animals and Man", which was arranged by the Singer–Polignac Foundation in June 1954. The papers and discussions are in the language of their contributors, French, German and English. The interest of this symposium is two-fold: first, the very wide range of organisms covered, and the inclusion of papers on instinctive behaviour in man, a very neglected aspect of this field; secondly, the fact that it afforded an opportunity for a further round in the important controversy between the so-called 'objectivist' school of ethologists led by Drs. K. Lorenz and N. Tinbergen, and their opponents from the ranks of the psychologists, led by Drs. T.-C. Schneirla and D. Lehrman.

It has always appeared unfortunate to some students of behaviour that the vast majority of the experimental evidence on which Lorenz's theory of instinctive behaviour is based has been derived from experiments on vertebrates. In the present symposium a number of papers on insects were given, including a notable summary by Prof. K. von Frisch of the behaviour of honey bees, and it is interesting to notice the emergence in the discussions of an idea that both innate and acquired behaviour in insects differs qualitatively from that of vertebrates by reason of the fundamentally different arrangement and operation of association centres in the central nervous system. Of great interest but of dubious value are the papers dealing with innate behaviour in men. This has always been a blind spot in the theorizing of human psychologists, and most followers of Freud and other classical analysts are aware of this deficiency; in fact, despite the investigations of infant psychology by Melanie Klein and her school there is little evidence for instinctive behaviour in humans. Thus the paper of Dr. M.-P. Bénassy in the present volume, attempting to recast the psychoanalytical theory of instinct, is of great interest, even if somewhat premature in face of the meagre data available.

It is, however, in the factual and theoretical papers on instinct in fish, birds and lower mammals that the back-bone and centre of interest of this symposium is to be found, and it is a pleasure to note how most speakers applied themselves closely to their required subject. Dr. Lorenz, indeed, applied himself so closely as to give what is probably one of the most precise and telling definitions of instinctive motor patterns ever made, to the exclusion of that part of his theory which deals with the role of the nervous system in instinctive behaviour, the kernel of which is his concept of the innate releasing mechanism. To some workers, especially physiologists, this may seem a cleverly calculated lapse, since it is precisely in this aspect of particulate function in the nervous system that his theory seems most fallible. In pursuit of the central controversy, the papers of Drs. Lehrman and Schneirla express their critical attitude towards the objectivist school; the title of Dr. Schneirla's paper, "Interrelationship of the 'Innate' and the 'Acquired' in Instinctive Behaviour", does perhaps express the core of their attitude, that Lorenz and his co-workers under-estimate the part that learning can play in the appearance of apparently innate behaviour patterns.

It would be foolish to expect that one symposium would result in the solution of this controversy about instinct; yet there are signs here and there in the discussions of a more liberal attitude by both sides in the argument, and surely this must be regarded as a most satisfactory outcome by the organizers. This stimulating set of papers is unfortunately marred by bad proof reading, and in a number of cases by such poor transcription or translation as to make certain passages meaningless. This is particularly so in regard to papers and discussions in English, but it also occurs in certain German papers. In places, the discussion reads as though certain questions and answers had been omitted. Page numbers are occasionally transposed in the text and in the table of contents several incorrect page numbers are given. These minor criticisms apart, however, the book may be recommended as a great fund of information and informative speculation on all aspects of 'instinct'—however one cares to define it.

P. T. Haskell

TOWARDS A STANDARD TERMINOLOGY IN STATISTICS

A Dictionary of Statistical Terms

By Prof. Maurice G. Kendall and Dr. William R. Buckland. Pp. x+493. (Edinburgh and London: Oliver and Boyd, Ltd., 1957. Published for The International Statistical Institute.) 25s. net.

FOWLER's "Modern English Usage" describes a dictionary as "concerned merely with words regarded as materials for speech", but adds, "since some information about the thing is necessary to enable the words to be used rightly, and opinions differ on the how much of this, most dictionaries contain some matter that is strictly of the cyclopædic kind". This book is a dictionary in the true sense, although much material of the encyclopædic type is included. It is the first comprehensive work of

reference of its kind and is needed. Scientists who use statistical analysis occasionally and professional statisticians should find it of most value—in the latter case mainly for terms outside their own special interests. It is not a book for the student.

The contents form a dictionary of terms with definitions in English, and four glossaries of the equivalent names in French, German, Italian and Spanish, in alphabetical order of the particular language. The glossaries give page references to the English definitions. The text is clearly printed and presented, in single column, and there seem to be few misprints of any importance. The terms included are mainly those which occur, in English usage, primarily in the science of statistics, but there are also a number from mathematics and other sciences, which are statistical in nature or important in the development of the subject. There are also definitions of terms current in Italian, for which there are no English equivalents. The many cross-references are an aid in tracing meanings.

It would be easy to criticize this book for its limitations—omissions of terms, slightness of historical references, arbitrary statements on controversial points—but Prof. M. G. Kendall has ably forestalled these criticisms in a paper read at the 1953 session of the International Statistical Institute. Most of the limitations are due to the rapid growth of the science and the lack of a tradition of standard terminology. The authors have aimed at producing a useful, medium-sized dictionary within a reasonable time, and, at present, no more could fairly be asked. It must be considered by these aims and, in particular, by the quality of the definitions.

These are, on the whole, accurate and clear so far as is possible. Thus the confusions in the definitions of, say, truncated and censored distributions are due to usage and not the authors. The standard, for terms on the borderline of statistical science, is not always so high; some demographic definitions, for example, standardization, life tables, are imprecise and even, perhaps, misleading. In a few instances descriptions of procedures are too condensed to be followed in practice, for example, Yates's correction.

It is arguable that the value of this work would be even greater if the material of an encyclopædic nature, particularly in the definitions of the more familiar terms, was reduced to allow for a wider scope and more references—in fact, if it was even more of a 'dictionary'. Perhaps it will tend this way in future editions.

W. Brass

INTRODUCTION TO MICROBIOLOGY

The Microbial World

By Prof. Roger Y. Stanier, Prof. Michael Doudoroff and Prof. Edward A. Adelberg. Pp. xxii+682. (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1957.) 8 dollars.

THE modern microbiologist, if he is to appreciate his subject to the full and if he is to make significant contributions in his own discipline, must, as the authors of this book insist, have a sound grounding in general biology with emphasis on the structure and mechanism of the cell. But that is not all; he must also have a sound knowledge of organic chemistry and biochemistry.

This book is directed to the beginner in microbiology, but without adequate chemical training he is unlikely to appreciate fully the sketches on the biochemistry and nutrition of micro-organisms. This being accepted, it must be said at once that the book is admirable for its purpose. It is obviously impossible, even were it desirable in a book for beginners, to treat in detail any one facet of microbiology as we now know it, but enough is said on each topic to arouse the interest of the reader.

The authors have had the happy idea of giving at the beginning of the book a selected bibliography of treatises on the history of microbiology, on the general properties of bacteria and viruses, on micro-organisms in disease, and on their industrial applications. They then proceed to construct a broad chart of their territory. There is little or nothing of importance in microbiology, particularly, as one might expect, in bacteriology, which is not dealt with. The text is well supported by many excellent illustrations, both line and plate. A good example is that which explains diagrammatically the reason for the inhibition of precipitation when either antigen or antibody is present in excess.

The authors have emphasized their own insistence on the value to the microbiologist of a biological background by including as Part 3 chapters on genetics, evolution, variation and natural selection of living organisms, supported by some physiology, biochemistry and nutrition. The events within the living cell are basically similar, and it is well that the importance of their study in micro-organisms should be recognized from the outset. This is an easy book to read and can be recommended to the beginner, and to those of greater stature who are willing to be entertained and even, perhaps, instructed.

A. T. R. Mattick

POPULAR GUIDES TO THE INTERNATIONAL GEOPHYSICAL YEAR

Guide to I.G.Y.

International Geophysical Year, 1957–8. Foreword by Sir James Wordie, and contributions by Members of the British Committee. Pp. 48. (London: Methuen and Co., Ltd., 1957.) 2*s*. 6*d*. net.

The International Geophysical Year

Unesco and its Programme XV. Pp. xx+x plates. (London: H.M. Stationery Office, 1957.) 3*s*. net.

The International Geophysical Year

By J. Wartnaby. (Ministry of Education: Science Museum.) Pp. v + 18 + 8 plates. (London: H.M. Stationery Office, 1957.) 2*s*. net.

THE International Geophysical Year began on July 1, and these three pamphlets for the general reader were published in June. "The Guide to the I.G.Y." is produced by the British National Committee for the International Geophysical Year, and contains contributions by members on their respective subjects—solar activity, cosmic rays, the ionosphere, aurora and airglow, geomagnetism, meteorology, glaciology, longitudes and latitudes, oceanography, and seismology, preceded by a foreword by the chairman, Sir James Wordie, and a summary by the secretary, Dr. D. C. Martin, of the interrelation of the subjects. An account of the United States

satellite plan has been provided by the U.S. National Committee. The inside front cover carries a map of the Antarctic with the positions of the various national stations and the inside rear cover the Geophysical Year calendar, with the dates of those special days and periods it has been possible to fix in advance for more concentrated observations. There will be other special periods, the Special World Intervals, on occasions of unusual solar phenomena, such as solar flares. The pamphlet concludes with a description of relatively simple apparatus for observing sunspots and roughly recording changes in magnetic variation which could be assembled in a school physics laboratory. The newer and less-tried methods of carrying instruments by rocket and artificial satellite are perhaps given undue prominence, and there is no mention in the text of the World Meteorological Intervals shown in the calendar. The pamphlet should be useful to a science teacher for preparing lessons on the Geophysical Year.

The Unesco pamphlet gives much more, but not altogether overlapping, information for sixpence more than the Guide. It includes many quantitative geophysical data and a detailed account of the history of the plan for the Year, naturally stressing the financial support given by Unesco. It goes into greater detail than the Guide, stating fully, for example, as the Guide does not, the reasons for the selection of particular dates and periods for the specially concentrated observations, and under "Measuring the Earth" it explains that it is hoped to increase the accuracy of knowledge of the distance between the continents from roughly 100 m. to 30 m. The pamphlet concludes with a useful glossary. It is not necessary to go to Antarctica to study lee-wave clouds as might be thought from the caption to a photograph of one, and there is no detailed calendar. Neither the Guide nor the Unesco pamphlet says enough about what will be done in the special days and periods; it is merely stated that observations too complex to be made daily will be made during them. Altogether, however, the Unesco pamphlet is strongly to be recommended.

The Science Museum pamphlet provides an easily readable, broadly popular, mainly qualitative, account of the aims and methods of the Geophysical Year.

G. A. Bull

PRIMES AND FACTORS

Factor Table for the First Ten Millions

Containing the Smallest Factor of Every Number not Divisible by 2, 3, 5, or 7 between the Limits 0 and 10,017,000. By Derrick Norman Lehmer. Pp. xvi+476. (New York and London: Hafner Publishing Company, 1956.) 160*s*.

List of Prime Numbers from 1 to 10,006,721

By Derrick Norman Lehmer. Pp. xv+133. (New York and London: Hafner Publishing Company, 1956.) 107*s*. 6*d*.

PRIME numbers have interested professional and amateur mathematicians for many centuries, and continue to do so. Many have made factor tables and lists of primes, culminating in the great factor table of Kulik to 100 millions; this remains in manuscript and is inaccessible, difficult to read, and full of errors.

For practical purposes the two volumes produced by D. N. Lehmer form the definitive tables for those needing factors of numbers and using primes not exceeding ten millions. These two volumes first appeared in 1909 and 1914. The first gives the least factors of all numbers up to 10,017,000 that are not divisible by 2, 3, 5 or 7, in an easily usable though (because of the absence of multiples of 7) not absolutely direct form. The second volume lists all primes from 1 to 10,006,721 in a manner allowing the rank (that is, n for the nth prime) to be easily extracted.

Lehmer's tables superseded the considerable earlier efforts of Burckhardt (first three millions), James Glaisher (fourth, fifth and sixth millions), Dase (seventh and eighth millions) and Dase and Rosenberg (ninth million). Of these, Glaisher's were remarkable for accuracy when they appeared, but all are surpassed in this respect by Lehmer's table. In the list of primes the only known errors are:

Page	Column	Line	For	Read
11	13	1	8151	8051
14	30	55	51	47
99	20	heading	224	724

although there are several missing rules, and a few misprints in the Introduction. No error is known in the Factor Table.

Lehmer's tables have been out of print for some time, so that the demand, constant over decades though not great, has led to a high scarcity price for second-hand copies, which are all too rare. It is therefore with much pleasure and interest that this new edition is received, of a standard, definitive and highly accurate work; it is time for the volumes to be generally available again.

The reproduction of the original tables was good, but the figures, typed and reduced, are considerably too small and the large page awkward to use; legibility was reduced by use of a yellowish paper. It is thus pleasant to record the use of a whiter paper, even though the page has, inevitably, the same layout and is of the same unwieldy size. One criticism may be mentioned; it is a pity that known errors were not corrected—as might easily have been done—before reproduction. Instead, an arbitrary hand-marked copy has been used, with errors apparently all noted, but no corrections given. The interest of a user of the original copy in early prime fours is unexpectedly evident! This is, however, only a minor criticism of a useful job well done.

We may, perhaps, note some further tables. There is the table published in 1951 which was prepared by Kulik, Poletti and Porter giving primes in the 11th million, and the manuscript factor table for this million prepared by N. G. W. H. Beeger in Amsterdam. There are also two sieves of primes, computed electronically on cards—one by D. H. Lehmer (son of D. N. Lehmer) prepared on SWAC at Los Angeles to about 35 million, and one prepared by D. O. Clayden on the pilot ACE at the National Physical Laboratory. The latter has been used to check a list of primes, prepared on EDSAC at Cambridge by the writer, that extends at present to 17 million. Thus Kulik's great work stands alone, even in the present day of electronic computation, just as Lehmer's tables are the outstanding published source.

J. C. P. Miller

OCCURRENCE OF STONE ARTEFACTS WITH *AUSTRALOPITHECUS* AT STERKFONTEIN

Part I

By Dr. J. T. ROBINSON
Transvaal Museum, Pretoria

IN May 1956 Dr. C. K. Brain, at that time working in the Department of Vertebrate Palæontology and Physical Anthropology of the Transvaal Museum on the australopithecine-bearing breccias, discovered some stone artefacts in breccia rubble near a small pit 55 ft. west of the Sterkfontein Type Site. The latter site yielded the *Australopithecus* and associated faunal material from Sterkfontein. At this time I was in the United States, and at my request a narrow zone of overburden was removed between the West Pit and the Type Site, revealing a continuous deposit of breccia between the two. Artefacts were found in the overburden, hence further removal was halted. After my return, the director of the Archæological Survey, Mr. B. D. Malan, agreed to collaborate with this Museum in certain aspects of the study of this site. To this end, Mr. R. Mason, assisted by Dr. Brain, conducted a pilot excavation of the overburden in January of this year (see Part 2). From mid-February until early June, I carried out an excavation of the *in situ* breccia in the region of the West Pit. This was made possible by a grant generously made available by Sir Wilfrid Le Gros Clark from the Boise Fund of the University of Oxford. Excavation has been discontinued, owing primarily to lack of funds, but a great deal remains to be done. The results already obtained are of obvious importance and are thus being published now; but it is manifest that more evidence is urgently needed before detailed conclusions can be drawn.

The newly exposed breccia is referred to as the Extension Site to distinguish it from the Type Site. A permanent grid base (steel wire on concreted steel rods) was set up at datum-level using a surveyor's level—which was also used for making a detailed map. 2-ft. grid intervals were used and 1-ft. levels were adhered to as nearly as the material allowed. Breccia was removed by means of a two-stroke drill and steel wedges. All the breccia removed was *in situ*, being part of a very large solid mass. Only material found *in situ* in this mass has been used; the original finds in rubble have thus been left out of account.

Stratigraphy. The Extension and Type Site breccias were regarded as being identical when the first artefacts were found, hence the latter were thought to be coeval with the Type Site *Australopithecus*. By the time the site had been fully prepared for excavation this conclusion seemed to me improbable, and excavation soon revealed that at least three breccias are involved. In the West Pit area a superficial, chocolate-brown breccia, with a maximum thickness of about 2 ft., overlies a much thicker red-brown breccia. The two are separated in this region by a rather thin stalagmite of variable thickness. The brown breccia contains fairly abundant remains of *Equus* but, so far, neither artefacts nor australopithecines. A volume of roughly 250 cu. ft. of red-brown breccia has yielded fifty-eight artefacts, abundant micro-mammalian remains, some artiodactyl and carnivore, but no *Equus* material, as well as M^1, dm^2 and dm^1 of *Australopithecus*. The latter tooth is fragmented but the others are well preserved, especially M^1, which appears to fall easily within the observed range of variation of the Type Site sample, and its identification is in no way uncertain.

The red-brown breccia affords clear evidence of a still older breccia in the neighbourhood in the form of inclusions, ranging in size from small pebbles to blocks 1 ft. across. These consist of consolidated breccia of a paler colour than the main mass and have sharply defined edges. They must consequently have been incorporated in the accumulating red-brown breccia as fragments of an older and already consolidated breccia. The colour of these fragments is very similar to that of most of the Type Site breccia. Evidence is available which suggests that the Type Site breccia is older than the red-brown breccia and hence may be the source of these inclusions.

The Type Site breccia yielded much *Australopithecus* but no *Equus* material, and in this resembles the red-brown breccia. However, no artefacts were recovered from the large volume of breccia removed from the Type Site, and a recent detailed examination of the whole of this site and the rubble from it, as well as an appreciable volume of breccia in our store-room, failed to provide any evidence of quartz, quartzite or diabase inclusions. In this it differs strikingly from the red-brown breccia. The west wall of the Type Site has an ill-defined unconformity which separates an upper level of breccia, which contains artefacts, from the typical Type Site breccia. The evidence thus suggests rather clearly that three breccias are present in the following order of decreasing age: pink, red-brown and brown. The pink breccia is known to be older than Swartkrans on climatic and faunal grounds. The lack of *Equus* in the red-brown breccia suggests that it also is older than Swartkrans although younger than the pink breccia; hence the age difference between these two is unlikely to be great since available evidence suggests that the age difference between the pink breccia and Swartkrans is not great[1]. No evidence is yet available regarding the relative ages of the brown breccia and Swartkrans.

The artefacts. Some of the artefacts from the red-brown breccia are unquestionably worked, while all but one are composed of material foreign to the site

and its immediate environs. This indicates that a true lithic culture is being dealt with. Being in an undisturbed, consolidated breccia, the artefacts are rather clearly of the same age as the breccia. Any possible doubts on this score are dispelled by the fact that not only the consolidated brown breccia overlies the red-brown, but also the sterile layer of overburden which Mr. Mason has demonstrated to underlie the Middle Stone Age layer. This excavation has thus demonstrated conclusively, for the first time, the synchronous presence in one site of an australopithecine and a lithic culture. This industry is not of the most primitive order, and Mr. Mason has concluded (see below) that the most advanced artefacts indicate a late Oldowan or very early Chelles–Acheul stage in the African Stone Age sequence.

The presence of stalagmite overlying at least a part of the red-brown breccia indicates that a substantial dolomite roof must still have been present over this area after the accumulation of that breccia. This shows, contrary to the belief of some students, that very early Stone Age artefact manufacturers sometimes did live in, or in the immediate vicinity of, caves.

Who made these artefacts? Since no other hominids are known from Sterkfontein, it would seem that it must have been *Australopithecus*. However, the degree of advancement of the industry makes such a conclusion dubious. Furthermore, artefacts are apparently absent in the type site whereas *Australopithecus* remains are common. It seems improbable that this is due to the fact that this creature learned to make tools subsequent to the time of the pink breccia, but had already achieved a considerable degree of advancement by the time of the red-brown breccia. Perhaps the very fact that *Australopithecus* is common at Sterkfontein is an argument against it being a tool-maker, since in all other very early Stone Age sites remains of the tool manufacturer are extremely rare.

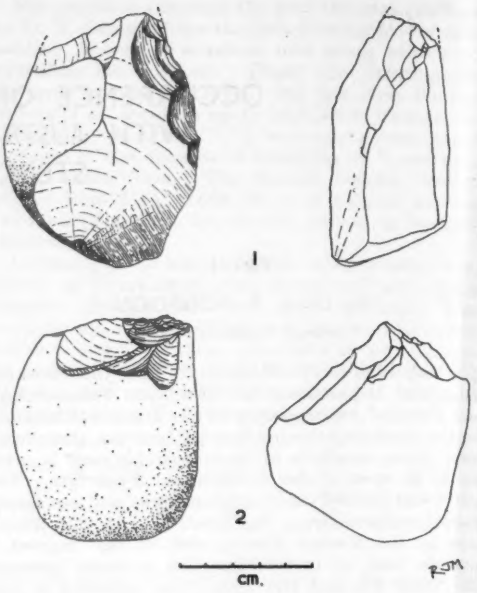

Fig. 2

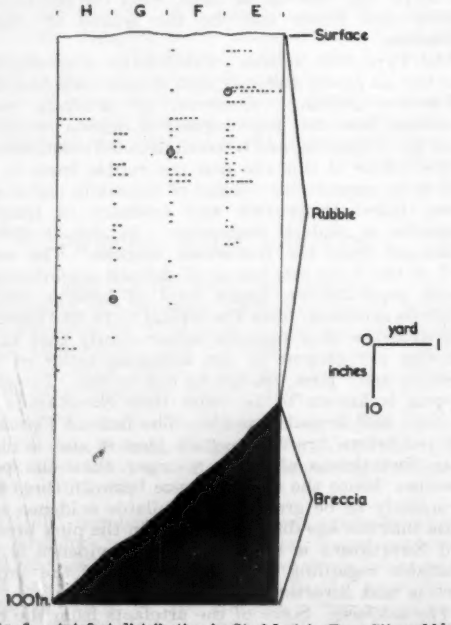

Fig. 1. Artefact distribution in Sterkfontein Type Site rubble, lane 4. Middle Stone Age artefacts, —; Earlier Stone Age artefacts, ○

The simplest explanation of the present facts seems to be that an early euhominid invaded the Sterkfontein area after the time of the pink breccia, but before the time of at least those levels of the red-brown which have been excavated.

It has been suggested above that the difference in time between the tool-bearing breccia of the Extension Site and Swartkrans, less than a mile away, is not great. In the lower levels of the latter site a few remains of *Telanthropus* were found. On anatomical grounds I have previously regarded this form as an australopithecine which had reached euhominid status[2]. If this view is correct, it is probable that this form had some sort of lithic culture. It is therefore not unreasonable to suppose that *Telanthropus* was the invading form responsible for the Extension Site artefacts. If it is assumed that the invader was not *Telanthropus*, then it must be concluded that *Paranthropus* and *Telanthropus* afterwards invaded the area and displaced or replaced *Australopithecus* at least, and perhaps the Extension Site tool-maker also. If *Telanthropus* displaced the latter form, it would imply that the former was the more advanced of the two hominids—in which case it is unnecessary to postulate the presence of the hypothetical form. If *Telanthropus* did not displace the other, it would follow that *Paranthropus*, *Telanthropus* and the hypothetical form simultaneously occupied the valley. Good evidence would be necessary before accepting such a complication. The most reasonable hypothesis at present is to attribute the red-brown breccia industry to *Telanthropus*, since this form is already known to exist in the area at about the right time-level. More evidence—which may well be present in the Extension Site—is urgently needed to shed further light on this interesting problem.

Part 2

By R. J. MASON

Archæological Survey of the Union of South Africa

Excavation of superficial rubble. During 1956 Dr. C. K. Brain discovered stone artefacts in the upper level of the Sterkfontein breccia and in a superficial rubble of soil, dolomite and chert fragments overlying it. Early in 1957, with the assistance of Dr. Brain, I excavated part of the superficial rubble with the object of determining its relation to the underlying breccia. A base-line was laid on the north side of the site and 12 sq. yd. of the rubble excavated to reach the breccia between 46 in. and 100 in. below the surface. The deposit was excavated in 2-in. layers to enable the exact position of each artefact to be recorded. Numerous artefacts, but not fauna, were found in the rubble as follows: (1) three Later Stone Age artefacts, small microlithic scrapers, on and just below the surface; (2) 304 Middle Stone Age artefacts, from 3 in. to between 37 in. and 60 in. below the surface; these are mainly highly characteristic flakes of Middle Stone Age type, a few carefully prepared cores and dimple-scarred upper grindstones; (3) three possibly Earlier Stone Age flakes; (4) seven river pebbles in quartzite and diabase.

The eroded surface of the breccia supporting the rubble slopes evenly from 70 in. to 100 in. below the surface, except for a mount on the upper edge of the slope. The 317 artefacts found in the rubble are distributed in depth as follows: 85 per cent occur between 3 in. and 37 in.; 14 per cent occur between 37 in. and 60 in.; 1 per cent occurs between 60 in. and 65 in.

The stratigraphy is shown in Fig. 1. It is important to note that the lower 28–40 in. of the rubble is sterile except for one artefact, a position that eliminates the possibility of artefacts from the overlying, later rubble entering the underlying, earlier breccia. It seems highly probable that artefacts found in the breccia must be truly *in situ*, and of the same age as the breccia.

The rubble bed represents a sediment lying unconformably on the surface of the breccia. The Middle Stone Age artefacts are fresh in contrast to the worn, oxidized appearance of the three Earlier Stone Age flakes. The latter would appear to be derived from an earlier deposit. The rubble is therefore mainly of Late Middle Stone Age date, and may be placed at the end of the Transvaal Pleistocene, as typologically similar artefacts have been discovered in a well-represented end-Pleistocene faunal bed at Kalkbank, near Pietersburg. The rubble bed closes the Sterkfontein type-site sequence and extends its length to the end of the Stone Age. Despite unconformities, the site therefore provides a truly remarkable record of protohuman and early human life and activity.

The industry from the red-brown breccia. Dr. Robinson's excavation of the red-brown breccia produced not only australopithecine and other faunal evidence but also fifty-eight artefacts, the preliminary description of which follows:

(1) Plain pebbles. Total 24. The pebbles vary from 48 mm. to 110 mm. in length. Most are angular but a few are rounded, suggesting that they were collected from the nearby Blaaubank river gravel. With the exception of the chert specimen, all are foreign to the dolomite cave rock and have therefore been deliberately carried to the site.

Materials:		
	Diabase	4
	Quartz	5
	Quartzite	14
	Chert	1

(2) Fractured or damaged pebbles. Total 23. The pebbles vary from 52 mm. to 115 mm. in length. All have been broken in one or more places, but none shows traces of deliberate flake detachment. Thirteen have bruised edges, indicating use as pounders or hammers.

Materials:		
	Quartz	12
	Quartzite	10
	Chert	1

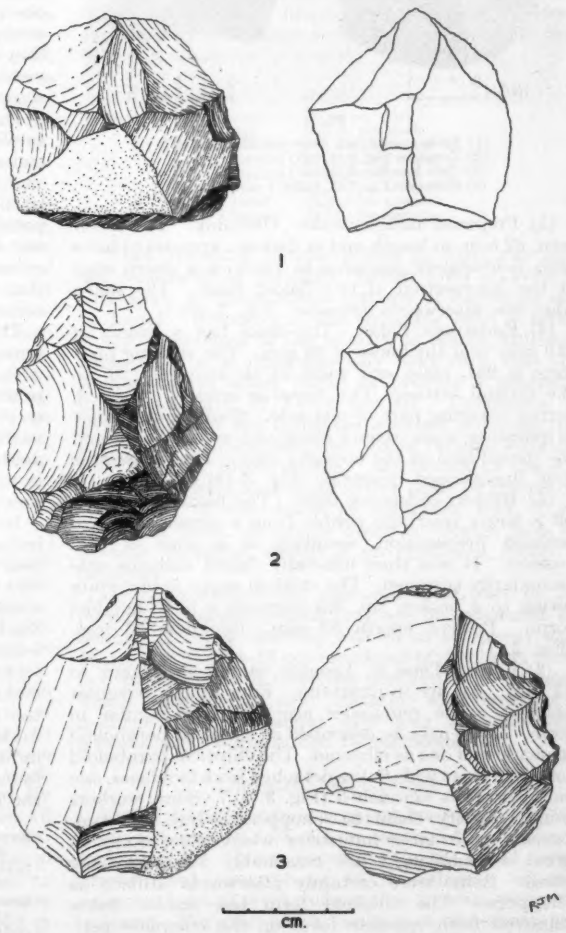

Fig. 3

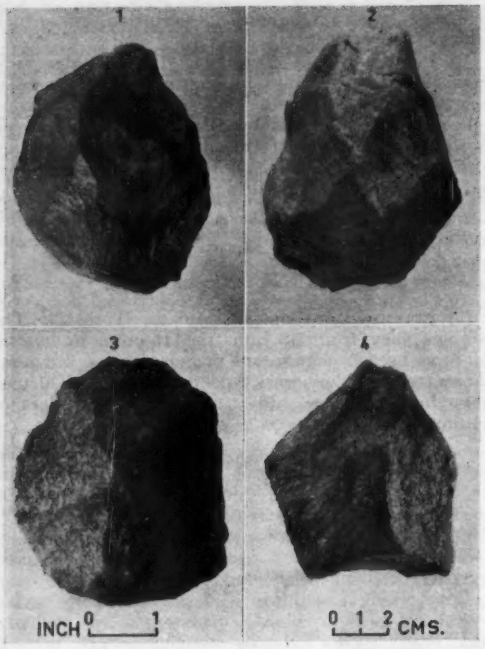

Fig. 4

(1) Broken endstruck flake (see Fig. 2 (1, left))
(2) Core (see Fig. 3 (2, left))
(3) Core (see Fig. 3 (1, left))
(4) Core (see Fig. 3 (1, right))

(3) Prepared hammerstone. One only. The specimen, 82 mm. in length and in diabase, appears to have been deliberately prepared to produce a sharp edge at the intersection of two flaked faces. The sharp edge was afterwards damaged (Fig. 2 (2)).

(4) Endstruck flake. The flake has a length of 110 mm. and thickness of 62 mm. The striking platform is flat, plain and wide, at an angle of 126° to the ventral surface. The dorsal is crudely prepared, cortex covering part of one side. Shallow secondary preparation scars extend along one ventral edge and the dorsal face of the opposite edge. The material is grey fine-grained quartzite (Fig. 3 (3)).

(5) Broken endstruck flake. The flake was struck off a larger quartzite pebble from a cortex platform without preparation, resulting in a cone of percussion. It was then bifacially flaked and one side secondarily trimmed. The original shape is uncertain owing to a broken tip, but suggests a hand-axe-like form. Present length 93 mm., thickness 43 mm. (Fig. 2 (1)).

(6) Cores. Total 8. Lengths vary from 70 mm. to 97 mm. All are in quartzite. Four are on irregular pebbles. The remainder are relatively regular in form. Three may be described as elliptical paraboloid in shape and one as ellipsoid. The elliptical paraboloid form has short wide flakes detached from two faces, one side being left untouched (Fig. 3 (1)). Some workers might classify them as 'choppers'; but, by comparison with later industries where they occur in great abundance, I am reasonably sure they are cores. Some were certainly afterwards utilized as choppers. The ellipsoid form has similar flakes removed from opposite faces on the complete perimeter (Fig. 3 (2)). The irregular cores yielded rough flakes from any convenient face, but did not produce as many flakes per core as the more regular forms. The flake-scars show that the cores yielded small flakes of no regular shape, about 50 mm. × 30 mm. × 20 mm. No trace of the faceted platform technique can be seen. It seems that the flakes were not specially prepared before detachment. After their use as cores, two of the elliptical paraboloid class were utilized as tools.

None of the flakes produced by these cores occurs in the deposit. No core present could have yielded the large flakes described in (4) or (5).

The associated australopithecine remains and stratigraphic position indicate an early date for the industry. It is clear that the industry cannot be assigned to the Kafuan culture if, as is claimed, that culture consists mainly of crudely trimmed pebbles. The more complex, flaking techniques of the Sterkfontein industry show marked similarities to those of the African Chelles–Acheul Stage 1 type series from the Older Gravels of the Klip River at Vereeniging, 76 miles from the site. The flakes, cores and other artefacts could all be found in a Stage 1 series. Some similarities to the Olduvai Bed 1 industry can be observed, especially the utilized cores and hammerstone. While no flakes have yet been described from that bed, some Olduvai Bed 1 cores could have yielded flakes similar to the Sterkfontein specimen shown in Fig. 3 (3).

The Sterkfontein industry is not complete, as the smaller flakes and larger cores are missing. The statistical significance of such a small sample is slight. Making allowance for these factors, it is possible that the Sterkfontein industry occupies a position intermediate between the Kafuan culture and the earliest stage of the African Chelles–Acheul culture. The hand-axe-like tool (Fig. 2 (1)) suggests that future excavations may reveal more advanced tool-types.

The Makapansgat Limeworks site has, like Sterkfontein, yielded australopithecine remains associated with stone tools from a horizon overlying a bed containing more abundant australopithecine remains but no stone tools[3]. Unlike the Sterkfontein industry, the validity of the Limeworks tools is open to some doubt. If the industry is valid, as it might be, it is more primitive in aspect than the Sterkfontein series.

In assessing the relationship of the Sterkfontein industry to the australopithecines, it is necessary to bear in mind the distinction between tool-making and tool-using[4]. There seems every possibility that the australopithecines were capable of tool-using, as Dart's extensive research suggests[5]. It seems that tool-making of the complexity shown in the Sterkfontein industry was probably beyond their ability, and must be ascribed to some more advanced hominid the remains of which are not necessarily preserved in the breccia. The relationships of these early industries will depend on a more comprehensive faunal dating and more representative samples of the industries than are at present available.

[1] Ewer, R. F., *Proc. Zool. Soc. Lond.*, **124**, 839 (1955); *S. Afric. Arch. Bull.*, **11**, 41 (1956).
[2] Robinson, J. T., *Amer. J. Phys. Anthrop.*, **11**, 1 (1953); *Transv. Mus. Mem.*, **9**, 171 (1956).
[3] Brain, C. K., van Riet Lowe, C., and Dart, R. A., *Nature*, **175**, 16 (1955). Dart, R. A., *Nature*, **176**, 170 (1955).
[4] Oakley, K. P., *Antiquity*, **30**, 4 (1956).
[5] Dart, R. A., *Transv. Mus. Mem.*, 10 (1957).

NATIONAL WAGE AND SALARY POLICY IN BRITAIN

By Dr. ELLIOTT JAQUES

RECURRING wage disputes, with their bitterness, disruption and inflationary impact, have pointed the need for more effective means of fixing wage- and salary-levels. Discussions of this matter commonly assume that disputes are primarily motivated by employees striving to push their earnings as high as they can, while employers strive to reduce their labour costs. The outcome of the ensuing struggle is held to be determined by the relative bargaining power of the two sides—a power situation the possible mitigation of which was one of the implications of the committee proposed as part of the recommendations in the recent wages dispute in the engineering and shipbuilding industries in Britain.

It may be, however, that it is precisely the assumptions made about collective human behaviour with respect to payment which require re-appraisal, and perhaps elaboration, if we are to order better this aspect of our economic life. For despite the evidence in favour of a predominantly nihilistic view of economic motives, there is also evidence that there exists in each person's mind an idea of a 'fair' rate of payment for the job he does. It is simply not the case that everyone is always agitating for more pay, or changing jobs to get it, or forcing down wages, even when in a position to do so.

This sense of fair payment can be shown to have a firm and objectively definable basis. Further, evidence has been found which suggests that this individual sense of fairness is part of a system of norms of what constitutes a fair rate for a given level of work, unconscious knowledge of these norms being shared among the working population. These observations—which depart from common expectation—have been made by means of a special method for analysing work. Their significance is that they point to a possible empirical basis for a national wage and salary policy based upon equity, and applying to all types of work, from managing director to shop floor.

Payment and Work

The results to be described have come mainly from applied research work carried out over the past eight years in conjunction with a light-engineering concern, the Glacier Metal Company. In the course of this work, it has been found that what is experienced as level or weight of responsibility in a job (which I shall hereafter refer to simply as *level of work*) can be measured by finding the maximum period of time during which the work assigned by a manager to a subordinate requires the subordinate to exercise discretion, or judgment, or initiative, in his work without that discretion being subject to review by the manager. The measure rigorously excludes all those aspects of work which are prescribed or regulated by policies, administrative routines, or physical controls, to which the subordinate must conform or be guilty of negligence. I have termed this measure the *time-span of discretion*; it has been described in detail elsewhere[1].

A maximum time-span of discretion exists in all jobs. Its major significance from the point of view of our present concern lies in the finding that individuals in jobs whose level of work measured in time-span is the same, privately state the same total earnings to be fair for the work they are doing. This finding was independent of income tax paid. I have called the pattern of payment so derived the *equitable work-payment scale*.

Illustrative examples of time-spans and the stated equitable earnings (as of February 1957, the amounts cited tending to change roughly in step with movements in the wages index) are given in Table 1. These figures are based on analyses of some thousand jobs of all types and at all levels, with additional confirmatory findings from a heavy-engineering firm, a food factory, a bank, and a chemical concern. The full scale comprises increments in time-span corresponding to increments ranging from 2 to 5 per cent in stated equitable payment.

Table 1

1 hour	£9 5*s.* per week
1 day	£10 5*s.* per week
1 week	£12 10*s.* per week
1 month	£13 10*s.* per week
6 months	£950 per annum
1 year	£1,250 per annum
2 years	£2,350 per annum
5 years	£4,750 per annum

When reactions of individuals to their payment are considered in the light of their level of work in time-span, a characteristic pattern of responses can be found. Payment at the equitable level is intuitively experienced as fair relative to others, although there may be a simultaneously held view that the economy as a whole ought to provide a generally higher standard of living for all. Deviations in payment below the equitable level are accompanied by feelings of dissatisfaction which become stronger the greater is the deviation. Deviations at the 10–15 per cent level lead to an active sense of grievance, complaints or the desire to complain, and, if no redress is given, an active desire to change jobs, or to take collective action if an organized group is involved.

Deviations above the equitable level (rare in the current inflationary situation) are accompanied by feelings of being *relatively* well off as compared with others; at the 10–15 per cent level of deviation there is a strong sense of receiving preferential treatment, which may harden into bravado, with underlying feelings of unease about how long the relatively advantageous position can be maintained.

Unstated Assumptions

Use of the time-span instrument has served forcibly to drive home the fact of how easy it is for arguments and disputes about payment to be based upon unwarranted assumptions in the absence of any common level of work referend as to what payment is about. For example, in the case of two stores, one was reputed to pay high wages and the other low

wages. Analysis of level of work, however, revealed that in fact the reputedly high-wage paying store had organized its sales work at a higher level than had the other. Its higher pay was for higher responsibility, and the pattern of rates in both stores turned out in fact to be consistent with the pattern of the equitable scale.

How often it occurs, however, that arguments of the above type take place in which comparisons with regard to pay are made between jobs, or different occupational categories, or indeed whole industries or social classes, and in which it is simply assumed that level of work is known. For example, what is a 'reasonable' wage for machine operators as compared with technologists and managers? What ought teachers to earn as compared with skilled craftsmen? Or the middle classes as compared with 'workers'? In the absence of a yardstick—and indeed of any common language even for talking about work—such questions defy systematic resolution.

Many such arguments can be shown to be not only futile, but also misleading. For example, changes can readily take place in jobs which, because they continue to bear the same title, continue to be referred to as the same job. Such comparisons are currently familiar in discussions about the trend of income of 'doctors' as compared with that of 'craftsmen', say, since 1939. The assumption is that the comparative levels of work have remained unchanged. This assumption may be warranted. But it may not be. In the British railway strike in 1955, a similar unrecognized assumption about comparative levels of work remaining unchanged was made in arguments about the comparative trend of earnings of footplatemen and porters since 1905. In this case, in view of the increasingly prescribed character of footplate work, the assumption was most probably not warranted.

In the same vein, supposed payment for scarcity value may not always be what it seems. For more often than not, in my experience, an apparent excess payment in fact turns out to be an increment to bring payment for a job up to the equitable level, in circumstances (common in the expanding technologies) where level of work had been increased without its being recognized, and without a concomitant increase in pay at the time. Until a common yardstick is agreed, it is better to recognize the lack of a yardstick than to argue as though levels of responsibility were clearly and precisely known.

National Payment Policy

Although the foregoing results need to be tested by more extensive studies, their consistency under intensive study in a few widely varying industries suggests the following broad outline of a systematic wage and salary policy. This policy is that of payment for level of work carried in each specific job at any given time. Custom and practice, advantageous position gained through scarcity, social stereotypes about manual as against non-manual types of work—all such criteria would have to be abandoned. Questions of socially necessary income—such as the requirements of those with large families or the needs of men as compared with women—would be matters of government policy, to be dealt with by such mechanisms as taxation and insurance.

This type of policy has two essential features. It rests upon a foundation of the explicit recognition and institutionalized acceptance of objectively discoverable norms of payment in relation to level of work; and it subjects everyone in industry—senior executive and unskilled worker alike—to the same scale of value for the work he does. The burdens of a non-abundant economy would be equitably shared; and increases in national productivity would be reflected in an upward shifting of the whole scale of payment. Individual progress in earnings relative to others could be obtained only by a person's attaining and carrying out higher levels of work—a condition fundamental to the creation of genuine incentive.

Although it is, of course, possible only to speculate, the hypothesis seems warranted that a strengthening of unity of effort to improve the health of the economy might be achieved. This unifying effect would come about from the fact not only that the effects of enrichment or impoverishment of the national economy would be equitably distributed over the total working population including the lowest to the highest paid, but that they could publicly be seen to be so distributed. There is plenty of evidence that absence of objective methods for settling payment-levels in a manifestly equitable manner stirs up widespread envy and mistrust, and causes an abdication of executive leadership, and socio-economic rivalry and stress such as seriously to impede the national recovery.

[1] Elliott Jaques, "Measurement of Responsibility"; and Hill, J. M. M., "The Time-Span Method of Job Evaluation" (Tavistock Publications).

COMPARISON OF CÆSIUM RESONATORS BY TRANSATLANTIC RADIO TRANSMISSION

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In the past few months, we have compared the frequencies of a cæsium resonator at the National Physical Laboratory and an 'Atomichron' manufactured by the National Company of Malden, Massachusetts. The National Physical Laboratory resonator has been described previously[1]. The 'Atomichron'[2] contains a crystal oscillator, frequency-deriving equipment, and a servo that controls the oscillator to maintain a derived frequency in agreement with that of a cæsium beam resonator. An output frequency of 100 kc./s. and others up to 100 mc./s. are provided. Only the lower frequency has been used in this study.

The measurements are made by using the *MSF* standard frequency transmissions[3] as an intermediate reference standard. The *MSF* service operated from

Rugby by the British Post Office on behalf of the National Physical Laboratory includes a transmission at 60 kc./s., and in order to facilitate long-distance comparisons the Post Office has also used the quartz oscillator which controls the frequencies of all the transmissions to control the carrier wave of the *GBR* 16 kc./s. transmitter.

At the National Physical Laboratory the ground-wave of the 60 kc./s. transmission of *MSF* is received and measured in terms of the cæsium atomic standard. The *MSF* standard is also measured in terms of one of the Post Office quartz clocks at Dollis Hill by land line, and this in turn is compared at the National Physical Laboratory with the cæsium standard by land line. In this way it is estimated that the *MSF* 60 kc./s. transmission and the daily average value of the *MSF* standard are both known in terms of the National Physical Laboratory cæsium standard with an accuracy of ± 2 parts in 10^{10}.

At Camden, New York, about 400 km. from Cambridge, Mass., the U.S. Air Force is conducting evaluation trials of an aid to navigation, 'Navarho', that involves transmission from station *AF2XKM* at 95 kc./s. with the carrier frequency controlled by a stable crystal oscillator. At the same station there are two 'Atomichrons'. Through the courtesy of the firm of Pickard and Burns, Inc., which is carrying out the evaluation for the Air Force, the transmitted frequency is rated daily in terms of an 'Atomichron', and the results are reported to Harvard. Transmission from Camden to Cambridge is dominated by the ground-wave, so that Doppler effects, when averaged over two or three hours, are quite unimportant.

At Harvard both the *GBR* and *AF2XKM* signal frequencies are measured in terms of a good crystal oscillator. Thereafter, addition and subtraction yield the received frequency of *GBR* with respect to the 'Atomichron'. These values are reported to the National Physical Laboratory.

Unfortunately, these comparisons were begun just as Rugby had to give up day-time transmission because of an aerial maintenance programme. This has limited the precision of these comparisons in two ways: the Doppler fluctuations in night-time transmission across the Atlantic Ocean are larger than those by day; and the various frequency comparisons cannot be made simultaneously, so that vagaries of the frequencies of the various oscillators become important.

The *MSF* signal is measured at the National Physical Laboratory between 20h. and 21h. G.M.T., and the *AF2XKM* frequency is compared with the 'Atomichron' over three or four hours centred at 15h. G.M.T. Because Doppler effects in transmission during the sunrise and sunset hours are serious (about two parts in 10^9 for the trans-Atlantic path) the *GBR* signal must be measured only during the few hours centred at about 3h. G.M.T., when the whole transmission path is in darkness. By measuring *AF2XKM* at Cambridge at the same time, reliance is placed on the Air Force crystal oscillator for interpolation. Alternatively, the oscillator at Harvard may be used for interpolation by measuring *AF2XKM* while that signal is being referred to the 'Atomichron'. Both methods are often used.

There have been many occasions when *AF2XKM* has not operated, or when at least one of the oscillators has been obviously unstable. Results for the dates when all measurements were successfully made are given in Table 1. The results are based on an adopted value of 9 192 631 830 c./s. for the cæsium resonance at zero magnetic field. The corrections for the field actually used are 1 c./s. for the National Physical Laboratory standard and 1·6 c./s. for the 'Atomichron'. The correction of 1 c./s. has been applied to the former results. The actual frequency of the 'Atomichron' is 9 192 631 831·6 c./s., but in order to simplify the electronic synthesis it was assumed to be 9 192 631 840 c./s. A correction of 8·4 c./s. (or 9 parts in 10^{10}) has therefore been applied.

Table 1. Daily Frequency Differences in Parts in 10^9

Date	*MSF* with respect to N.P.L. cæsium standard reduced to 9 192 631 830 c./s.	*GBR* with respect to 'Atomichron' as observed	*GBR* with respect to 'Atomichron' reduced to 9 192 631 830 c./s.	'Atomichron' with respect to N.P.L. cæsium standard	Monthly average
1956					
Nov. 16	+0·9	+2·5	+1·6	−0·7	−0·7
17	+0·5	+2·2	+1·3	−0·8	
27	−2·6	−1·0	−1·9	−0·7	
30	−1·9	−0·5	−1·4	−0·5	
Dec. 3	−1·4	−0·3	−1·2	−0·2	−0·2
4	−1·5	0·0	−0·9	−0·6	
5	−1·2	+0·4	−0·5	−0·7	
7	−0·9	0·0	−0·9	0·0	
13	−0·2	+1·0	+0·1	−0·3	
18	+0·6	+1·3	+0·4	+0·2	
20	+0·9	+1·1	+0·2	+0·7	
27	+1·5	+2·6	+1·7	−0·2	
31	+1·8	+3·1	+2·2	−0·4	
1957					
Jan. 2	+0·7	+1·4	+0·5	+0·2	−0·6
3	+0·8	+1·2	+0·3	+0·5	
28	+0·8	+2·5	+1·6	−0·8	
29	+0·9	+2·3	+1·4	−0·5	
30	+0·6	+2·6	+1·7	−1·1	
31	−0·2	+2·5	+1·6	−1·8	
Feb. 13	+1·0	+3·3	+2·4	−1·4	−0·8
14	+1·6	+3·1	+2·2	−0·6	
19	+1·4	+3·4	+2·5	−1·1	
20	+1·8	+3·4	+2·5	−0·7	
21	+1·8	+3·2	+2·3	−0·5	
23	+1·7	+3·4	+2·5	−0·8	
26	+2·1	+3·5	+2·6	−0·5	
28	+1·8	+3·5	+2·6	−0·8	
Mar. 6	+2·5	+3·4	+2·5	0·0	−0·5
8	+1·9	+3·8	+2·9	−1·0	
12	+2·3	+3·8	+2·9	−0·6	
14	+2·1	+3·8	+2·9	−0·8	
20	+3·1	+4·2	+3·3	−0·2	
April 2	+2·7	+5·0	+4·1	−1·4	0·0
3	+2·9	+4·3	+3·4	−0·5	
4	+3·4	+4·0	+3·1	+0·3	
5	+3·2	+3·8	+2·9	+0·3	
17	+4·5	+5·0	+4·1	+0·4	
18	+4·5	+4·6	+3·7	+0·8	
19	+4·1	+4·9	+4·0	+0·1	
23	+4·1	+5·3	+4·4	−0·3	
24	+4·6	+5·2	+4·3	+0·3	
25	+4·5	+5·4	+4·5	0·0	
29	+4·2	+5·0	+4·1	+0·1	
30	+4·2	+5·1	+4·2	0·0	
May 1	+4·5	+5·4	+4·5	0·0	−0·2
2	+3·9	+5·1	+4·2	−0·3	
3	+4·0	+5·2	+4·3	−0·3	
6	+4·2	+5·4	+4·5	−0·3	
7	+4·5	+5·2	+4·3	+0·2	
8	+4·5	+5·0	+5·0	−0·5	
10	+4·2	+5·0	+5·0	−0·8	
13	+4·3	+5·8	+4·9	−0·6	
23–25	−0·8	−0·2	−1·1	+0·3	
27–29	+0·7	+2·0	+1·1	−0·4	
29–31	+0·6	+2·0	+1·1	−0·5	
30–June 1	+1·0	+1·6	+0·7	+0·3	

Mean value, −0·4. Standard deviation of single observation, 0·4

With observations lasting three or four hours, it appears that the measurements of the *AF2XKM* frequency at Camden and at Cambridge can both be made to a very few parts in 10^{11}. Because of the requirement for interpolation, however, we need to

Table 2. Errors in the Measurement of Cæsium (U.K.) versus Cæsium (U.S.A.)

Component of the measurement	Standard deviation in parts in 10^9
AF2XKM relative to 'Atomichron'	0·1
AF2XKM relative to oscillator at Harvard	0·2
GBR relative to oscillator at Harvard	0·3
GBR relative to NPL cæsium resonator	0·2
Resultant	0·4

estimate the stability of the oscillators rather than the measurability of their average frequencies. On one occasion there has been a nearly continuous measurement of the *AF2XKM*-'Atomichron' difference over a period of 72 hr. There was no evidence of diurnal variation greater than 1 in 10^{10}, and the standard deviation was $0{\cdot}14/10^9$. It is not known whether this value was dominated by the instability of the 'Atomichron' or of the crystal oscillator, or both. A similar test of the oscillator at Harvard with respect to *AF2XKM* showed a slightly larger diurnal variation and had a standard deviation of $0{\cdot}19/10^9$. It should be noted that this value includes the propagational effects between Camden and Cambridge. Because there is no marked diurnal variation, we may take the uncertainty due to interpolation as being of the same magnitude as the standard deviations cited above.

The uncertainty caused by propagation of the *GBR* signal across the Atlantic Ocean has been estimated previously[4]. For night-time transmission and a four-hour measurement interval, the standard deviation is expected to be about $0{\cdot}3/10^9$. The various errors, assumed to be uncorrelated, are summarized in Table 2.

This summary value is in agreement with the experimental standard deviation given at the foot of Table 1. Because the errors are determined largely by the transmission variations on the trans-Atlantic path, there is little improvement in accuracy to be expected until day-time transmission is again available. With such transmission, however, simultaneous measurements of suitable duration should give results accurate to at least one part in 10^{10}.

The average difference between the frequencies of the National Physical Laboratory standard and the 'Atomichron' is within the accuracy claimed for the latter. However, one of us (J. A. P.) is confident that the average value of the Doppler shifts in propagation is near zero under the conditions of this experiment; and the others (L. E. and J. V. L. P.) think that it should be possible to construct cæsium standards of the same basic designs as those used in this experiment to agree to ± 2 parts in 10^{10}.

The important fact established by the comparison is that two standards completely different in their detailed design can be constructed and operated with such close agreement in widely separated parts of the world.

Two of us (L. E. and J. V. L. P.) would also like to comment that the major part of the work involved in the comparisons was that carried out at Harvard. The measurements made at the National Physical Laboratory are now part of the regular routine adopted in establishing an atomic time-scale and monitoring the *MSF* transmissions.

The work carried out at the National Physical Laboratory is part of the research programme of the Laboratory, and the results are published by permission of the Director. The work in the United States was made possible by support extended to Cruft Laboratory, Harvard University, jointly by the Navy Department, the Signal Corps of the U.S. Army, and the U.S. Air Force, under Contract *Nonr*–1866(07).

[1] Essen, L., and Parry, J. V. L., *Nature*, **176**, 280 (1955); *Phil. Trans. Roy. Soc.* (in course of publication).
[2] An article describing the 'Atomichron', by J. H. Holloway and J. R. Zacharias, is being submitted to the *Rev. Sci. Instr.*
[3] Essen, L., *Proc. Inst. Elect. Eng.*, Part III, **101**, 249 (1954). Law, H. B., *ibid.*, **102** B, 166 (1955). Steele, J. McA., *ibid.*, **102** B, 155 (1955).
[4] Pierce, J. A. *Proc. Inst. Rad. Eng.* (in course of publication).

NEWS and VIEWS

THE BRITISH ASSOCIATION:

New President

Sir Alexander Fleck has been elected by the General Committee of the British Association for the Advancement of Science as president of the Association for 1958. He will preside over the annual meeting at Glasgow during August 27–September 3, 1958. Sir Alexander, who has been chairman of Imperial Chemical Industries, Ltd., since 1953, was born in Glasgow and educated at Hillhead High School and the University of Glasgow. After graduation he held for a brief period a teaching appointment in the Chemistry Department of the University. Although his first paper was on the analysis of cyclohexane in benzene and was published in conjunction with the late Prof. T. S. Patterson, his important researches at that time dealt with the chemistry of the radioelements, especially those of short life such as radium-A, radium-B and radium-C. His first paper in this field was read to Section B (Chemistry) of the British Association at its Dundee meeting in 1912. His work provided the first experimental demonstration of the validity of the concept of isotopes. Fleck's research activities continued after he joined the Castner–Kellner Alkali Co. during the First World War, and he made an extensive study of anhydrous caustic soda and its behaviour in the presence of sodium metal. This work has not been published. In 1920 the Castner–Kellner Alkali Co. became a subsidiary of Brunner, Mond and Co., and the I.C.I. merger in 1926 gave Fleck's talents wider scope. By 1931 he had become managing director of the General Chemicals Division and six years later was appointed chairman of what is now the Billingham Division. In 1946 the Wilton project was added to his responsibilities and in 1951 he became deputy chairman of the main board. In recent years Fleck has received many honours, including the K.B.E., the fellowship of the Royal Society and three honorary doctorates. It is characteristic of his physique and his restless energy that tree-felling is one of his few relaxations.

Gifts to the Association

Sir George Allen, secretary of the British Association for the Advancement of Science, has announced that, as a result of approaches to a small number of leading industrialists, a very substantial addition to the income of the Association for the next seven years has been obtained. £40,000 has already been received, giving an additional £8,000 income for the coming year. It is now proposed to widen the appeal. Owing to the generosity of this same group of industrialists, it will be possible during the coming year to extend the Association's activities, and detailed plans for the future, which will include inter-meeting activities, are being discussed.

Endeavour Prizes

The prizes awarded by the British Association for the 1957 Endeavour Essay Competition were presented by Prof. P. M. S. Blackett, on September 5, during the reception for exhibitioners. The competition is sponsored annually by Imperial Chemical Industries quarterly review *Endeavour*, and is limited to those under twenty-five years of age. Seventy-three entries were received, many from abroad, and the prize-winners were as follows: first prize of 50 guineas to Miss Ruth Kirkland, of Sydney, Australia, for an essay on "Particles in Plant and Animal Cells"; second prize of 25 guineas to Mr. R. B. Cain, of Smethwick, Staffordshire, for an essay on "Chemistry and the Conquest of Disease"; third prize of 15 guineas to Mr. Charles Elliott, of Yorkshire, for an essay on "The International Geophysical Year". Two special prizes of 5 guineas were awarded to competitors under eighteen years of age. Mr. Geoffrey Benjamin, of Swansea, won one of these for an essay on "Particles in Plant and Animal Cells". Miss Dorothy Haas, of Birmingham, won the other for an essay on "Chemistry and the Conquest of Disease". An additional special prize of 3 guineas was awarded to Mr. Robin Jones, of Farnborough, for an essay of great merit.

Atomic Energy Authority: Sir Leonard Owen, C.B.E.

Sir Leonard Owen, director of engineering and deputy to the managing director of the Industrial Group of the Atomic Energy Authority, has been appointed managing director of the Industrial Group in succession to Sir Christopher Hinton, who has been appointed chairman of the Central Electricity Generating Board. Sir Leonard, who is sixty, has been engaged in the development of Britain's atomic energy programme since 1946, when he was appointed director of engineering on the production side. In the following year he became assistant controller in the Atomic Energy Division's production side. When the United Kingdom Atomic Energy Authority was formed in 1954, he was made director of engineering and deputy managing director.

Sir Leonard was educated at Liverpool Collegiate School and the University of Liverpool, where he obtained the degree of M.Eng. During the First World War he was with the 6th King's Liverpool Regiment, and afterwards was successively with Brunner, Mond and Company and I.C.I. (Alkali), Ltd., with whom he was engaged in the Engineering Department, designing new chemical plant and additions to existing chemical plant. During 1940–45 he was on loan to the Ministry of Supply as Director of the Royal Filling Factories.

University College of North Wales: Dr. R. C. Evans

Dr. Robert Charles Evans, who has been appointed principal of the University College of North Wales from September 1, 1958, in succession to Sir Emrys Evans, was educated at Shrewsbury School and University College, Oxford, and has, since 1947, held surgical appointments at the Northern, Walton and Southern Hospitals, Liverpool. During 1943–46 he was on active service with the R.A.M.C. and was mentioned in dispatches. In 1953, as Hunterian professor, he lectured to the Royal College of Surgeons on the physiological problems of adaptation to high altitudes. It is as a mountain climber that Dr. Evans is best known to the general public and particularly for his part in the Everest Expedition of 1953, on which he was deputy leader and as 'quartermaster' had responsibility for organizing the stores. On that Expedition he reached the South Summit of Everest, but as leader of the Kanchenjunga Expedition of 1955 he reached the summit except for the last few feet, which, with characteristic consideration for the feelings of the Sikkimese, he left untouched. The conquest of Kanchenjunga is described in his book, "Kanchenjunga, the Untrodden Peak" (1956). Dr. Evans was awarded the Cullum Medal of the American Geographical Society in 1954, the Livingstone Medal of the Scottish Geographical Society in 1955 and the Founder's Medal of the Royal Geographical Society in 1956.

NATURE

BRITISH ASSOCIATION NUMBER

Messrs. Macmillan regret that copies of "Nature" of September 7 were not generally available in Dublin as advertised. The issue was printed and dispatched in good time but delayed in transport through circumstances outside their control

British Institution of Radio Engineers: Awards

The British Institution of Radio Engineers has recently awarded the following premiums to authors of papers published in its *Journal* during 1956: Clerk Maxwell Premium, to Dr. K. D. Froome (Metrology Division of the National Physical Laboratory) for his paper, "Microwave Determinations of the Velocity of Light"; Heinrich Hertz Premium, to Dr. A. G. Edwards (Associated Electrical Industries, Ltd.) for his paper, "The Effects of Atmospherics on Tuned Circuits"; Brabazon Premium to K. E. Harris, (Director of Research, Cossor Radar Ltd.), for his paper, "Some Problems of Secondary Surveillance Radar Systems"; Louis Sterling Premium to Dr. A. van Weel (Philips Research Laboratories, Eindhoven), for his paper, "Some Remarks on the Radio-

frequency Phase and Amplitude Characteristics of Television Receivers"; Marconi Premium to Prof. P. M. Honnell (Washington University, St. Louis), for his paper, "Prescribed-Function Vibration Generator"; Dr. Norman Partridge Memorial Award to H. J. Leak for his paper, "High Fidelity Loudspeakers: the Performance of Moving Coil and Electrostatic Transducers".

Gas Council Research Scholarships

The Gas Council has awarded research scholarships to the following students who have recently graduated in physics, chemistry or engineering: A. Richmond (University of Oxford, Department of Inorganic and Physical Chemistry), the mechanism of gaseous oxidation processes; K. J. Reid (University of Cambridge, Department of Chemical Engineering), chemical engineering fundamentals; P. Hawtin (University College, London, Department of Chemical Engineering), heat transfer with a special interest in heat transfer to gases; D. Wilson (University of Birmingham, Department of Chemical Engineering), gas absorption; J. N. Sherwood (University of Glasgow, Department of Chemistry), diffusion studies in molecular crystals.

National Vegetable Research Station Association

The National Vegetable Research Station at Wellesbourne, Warwick, is proposing to form a National Vegetable Research Station Association. The Research Station welcomes contacts with growers. It already owes much to those growers who have assisted in its establishment and subsequent development. The Association is being set up to advance the knowledge, science and practice of vegetable production. Any member (grower or other interested person or firm) will be able to keep in touch with the latest research developments at the Station. He will receive copies of the Station's annual reports and will have the privilege of attending members' days. These days will provide opportunities for the interchange of ideas between research workers and growers, and will enable members to see and discuss work being done at the Station, to keep themselves abreast of the latest progress, and to meet other growers with common interests. Further information can be obtained from the Secretary, National Vegetable Research Station, Wellesbourne, Warwick.

Advice on Careers

Although the Youth Employment Service is performing a useful service in helping school-leavers to find and settle down in the right jobs, the schools have still an important part to play in helping scholars to decide on the kind of career which would be most suited to them. Many teachers are regrettably ill-equipped to give vocational advice, and, to help them, the National Union of Teachers has produced a useful pamphlet. Besides the many advertisements by business, industrial and other organizations—the value of which is open to question—the pamphlet contains a number of notes and articles which are both practical and up to date and should be of considerable assistance to careers masters and mistresses. These include such topics as the employer's expectations from the applicant, the essentials of apprenticeship schemes, universities and admission procedure, the role of the trade unions, careers for girls, selection procedure in industry and commerce and many others. The pamphlet contains exhaustive lists of valuable addresses. Copies can be obtained from the National Union of Teachers, Hamilton House, Mabledon Place, London, W.C.1.

Nature Reserves

Forty years after its founding, the Society for the Promotion of Nature Reserves has been taking stock. Despite the advent of the Nature Conservancy, the number of inquiries received during 1956–57 from other organizations and individuals interested in the acquisition of Nature reserves shows that the Society still performs an important function. In respect of at least seven of the inquiries discussions are still continuing with interested local individuals and organizations to see whether certain areas can be designated as Nature reserves. The fortieth annual report contains details of how existing Nature reserves are being managed and developed; these vary from Badgeworth Marsh in Gloucestershire, which was acquired solely to protect the very local buttercup, *Ranunculus ophioglossifolius*, to Scotton Common Nature Reserve in Lincolnshire, an area of about forty acres and one of the best of the few remaining tracts of blown-sand heathland in north-west Lincolnshire. Details of all the business transacted by the Society during 1956–57 are contained in the report, which may be obtained from the Society, British Museum (Natural History), London, S.W.7, price 5*s*.

Instrumentation for Gas Chromatography

The Scott microflame detector has now been made available commercially for gas chromatography (Shandon Scientific Co., Ltd., 6 Cromwell Place, London, S.W.7). This novel detector (Scott, R. P. W., "A New Detector for Vapour Phase Partition Chromatography"; see "Vapour Phase Chromatography", edited by D. H. Desty, p. 131; Butterworth, 1957) depends on the use of a carrier gas containing a considerable proportion of hydrogen, which is burnt in a small flame near the column exit. The presence of an organic vapour in the gas increases the length of the flame, and this results in a comparatively large response from a thermocouple situated just above the normal flame. The advantages of this detector are that it has an extremely small effective volume, resulting in a very rapid response; and secondly, that its response is directly proportional to the calorific value of the vapour; which means that in the analysis of hydrocarbons, calibration of the detector for individual compounds is unnecessary.

A New Submarine Mountain in the Pacific Ocean

A submarine mountain (31° 34·7′ N., 131° 08′ E.), named after Prof. T. S. Isakov, was discovered by the U.S.S.R. Expedition S.S. *Vityaz* on September 27, 1955 (Sergeev, I. V., and Udintzev, G. B., *Doklady Akad. Nauk., S.S.S.R.*, 113, 1123; 1957). This mountain rests on a 5,000 m. platform and its top is situated at the depth of 1,400 m. Its cone-shaped form and the dredged fragments of volcanic rocks suggest a volcano.

Silvina Estrada de Acevedo Fellowship for Research in Experimental Leukæmia

This fellowship, instituted by Don Horacio Acevedo in memory of his wife, for furthering research in experimental leukæmia, is open to scientists from any

part of the world who have already been working in this field. It involves full-time work at the Department of Experimental Leukæmia, Blood Research Institute, National Academy of Medicine, Buenos Aires, for one year, from February 1, 1958. The grant may be extended for a second period of one year, should the progress of the investigations appear to justify it. Its value is 5,000 Argentine pesos per month. Applications should be sent not later than November 30 to Fundaleu, Instituto de Investigaciones Hematológicas, Academia Nacional de Medicina, Melo 3081, Buenos Aires, Argentine. Applicants should give details of their educational and scientific qualifications, as well as a programme of the research they intend to do.

Biological Productivity of Britain

On October 4 Lord St. Aldwyn, Parliamentary Secretary to the Ministry of Agriculture, Fisheries and Food, will open, in the Lecture Hall of the Royal Geographical Society, a two-day symposium on "The Biological Productivity of Britain". The symposium is being arranged by the Institute of Biology to discuss the basic productivity of Britain—that of its land and inland waters. The papers to be given will deal with such subjects as the land-use pattern, the factors controlling photosynthesis, the present agricultural production, future improvements in plant and animal production, the production of lakes and of forests, the effect of controlled irrigation, the future of British uplands and finally the production of foodstuffs by unconventional methods. The symposium will be open to all interested. Further information can be obtained from the Institute of Biology, 41 Queen's Gate, London, S.W.7.

Lecture Courses in Nuclear Power

Two courses of lectures on nuclear power are to be given at the Northampton College of Advanced Technology, St. John Street, London, E.C.1. One is a course of twenty lectures entitled "An Introduction to Nuclear Power", to be given on Friday evenings commencing on October 11. The fee for the course is £2. The other course will deal with "The Engineering Design of Nuclear Power Plant", and will be given on Tuesday evenings commencing on October 15. The fee for this course is £1 10*s*. Further information can be obtained from the Principal of the College.

Institute of Fuel

The following forthcoming meetings have recently been announced by the Institute of Fuel: (1) "Flames and Industry", a one-day Symposium, arranged in conjunction with the British Flame Research Committee of the International Flame Radiation Research Foundation, to be held on October 9, at the Institution of Civil Engineers in London; (2) "Pulverized Fuel", a two-day conference, bringing up to date the report on the Harrogate Conference of 1947, to be held on November 27 and 28, at the Institution of Civil Engineers in London; (3) "Science in the Use of Coal", a residential conference to be held at the University of Sheffield during April 15–18, 1958; (4) the Seventh International Symposium on Combustion, organized in collaboration with the Combustion Institute, a residential Conference opening at the Royal Institution in London on August 28 and continuing at Oxford during August 29–September 3, 1958; (5) "Major Developments in Liquid-Fuel Firing, 1948–1959", a residential conference to be held at Torquay during May 11–14, 1959.

Announcements

The following officers of the Institution of Civil Engineers were elected for 1957–58: *President*, Sir Arthur Whitaker; *Vice-Presidents*, Prof. A. J. S. Pippard, A. C. Hartley, Sir Herbert Manzoni, Sir George McNaughton; *New Members of Council*, A. J. Dickson, F. N. Green, R. le G. Hetherington, E. A. F. Johnston, J. C. Macgregor, H. D. Morgan, T. P. de S. Munasinghe, J. F. Pain, I. W. Pugh, L. G. Smith, N. D. E. Stephens, Dr. Frederick George Thomas.

The Chemical Research Laboratory of the Department of Scientific and Industrial Research, Teddington, Middlesex, is to hold three open days during October 1–3, when visitors will be able to view work in progress. Inquiries should be addressed to the Director.

An international symposium on "Electronic Components" will be held at the Royal Radar Establishment, St. Andrew's Road, Malvern, Worcestershire, during September 24–26. Further details can be obtained from Mr. J. M. Robertson, Visits Office, Royal Radar Establishment.

A course of eight lectures on "Operational Research and Cybernetics" will be given at the Sheffield College of Technology, on Wednesdays, commencing on October 9. The fee for the course is £5 5*s*. Further information can be obtained from the Registrar, College of Technology, Holly Street, Sheffield, 1.

A conference on "Plasma and Atomic Physics", organized by the Physical Society, is to be held at the Atomic Energy Research Establishment, Harwell, on October 3 and 4. Copies of the programme and application forms can be obtained from the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

The eighteenth National Conference for the Preservation of the Countryside will be held at Hastings during October 17–19 on the theme: "Rural Problems of the Moment". All inquiries should be addressed to the Secretary of the Council for the Preservation of Rural England, Sir Herbert Griffin, 4 Hobart Place, London, S.W.1.

A conference on "Lubrication and Wear" has been organized by the Institution of Mechanical Engineers and will be held in London during October 1–3. The various sessions will be devoted to hydrodynamic lubrication, boundary friction, boundary lubrication, bearing metals and other materials, ball and roller bearings and special applications. Further information can be obtained from the Secretary, Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1.

A meeting of the Physical Society will be held at 6 p.m. on October 3 in the Physiology Lecture Theatre, Oxford, on the occasion of the presentation of the eighth Charles Chree Medal and Prize to Dr. D. F. Martyn (Commonwealth Scientific and Industrial Research Organization, Australia), in recognition of his valuable work on ionospheric physics. Dr. Martyn will speak on "The Ionosphere as Dynamo and Motor".

TECHNICAL EDUCATION AND INDUSTRIAL TRAINING IN MALTA

THE development of education in Malta has been very slow and, until recently, technical education almost non-existent and industrial training and apprenticeship schemes confined mainly to H.M. Dockyard.

With the grant of internal self-government in 1921, an extensive school-building programme commenced, which much improved the position, but not sufficiently to catch up on the neglect of decades.

Compulsory primary education for all children was not introduced until 1946, when the second period of internal self-government started. But there was insufficient school accommodation, and consequently, in order to cope with the big influx of children, the Government had to introduce a 'two-shift' system by which children received tuition for half-days only.

When the present Government took office in 1955, it immediately gave education top priority in its development plans. It initiated a very large school-building programme, and took over a number of private houses as temporary classrooms. This, together with the recruitment of a large number of temporary teachers, made it possible to abolish the half-time system and provide full-time primary education in 1956.

The Government was determined that the whole education system should be rebuilt from the bottom upwards, and that particular emphasis should be placed on technical education, thus avoiding the mistakes made in some Colonies where education has tended to develop from the university downwards, and too much emphasis has been placed on the grammar-school type of tuition.

The school-building programme has been astonishingly successful, and great credit must go to the Minister of Education herself—the Hon. Miss Agatha Barbara—for her enthusiasm, drive and exhortations. It is no uncommon sight to see Miss Barbara down on a building site spurring on the architects and workmen to greater efforts for the sake of their children.

So far, thirty primary schools and extension blocks have been completed or are in the course of construction; thirteen are in this year's programme (work on some of them has already begun) and thirteen more will probably be started next year. A technical school for a thousand boys will be completed in a few months time, work has just started on a technical school to house a thousand girls, and a second boys' technical school and a secondary modern type of school for boys will be started next year. Another three years will see the end of the present primary school-building programme.

At the moment only 9 per cent of primary school leavers are able to get any sort of secondary education. The present school-building programme, together with the Government-financed extension to St. Patrick's Technical School, will increase this to 20 per cent: 10 per cent to grammar and secondary modern, and 10 per cent to secondary technical schools.

Nor are the other aspects of development being neglected. The output of the local teachers' training colleges has been stepped up, and teachers are being recruited from overseas for short periods, while Maltese teachers and students are being sent overseas for further education. Unfortunately, the Royal University of Malta has no Education Department.

The hitherto backward state of education has been an important factor contributing to the underdevelopment of the Maltese economy. This has necessitated large-scale emigration, which has deprived the country of its more virile, adventurous and skilled workers, and created an unbalanced population structure: that is, an excess of 20,000 women over men, and fewer and fewer able young working men having to support a proportionately larger number of old people, women and children. This in turn has retarded development and created a feeling of apathy and despair.

There was obviously only one solution: to make a determined effort to develop the economy, particularly through industrialization and the expansion of the tourist industry. One of the pre-conditions of any development was a thorough reform of the whole educational system. Thus the Government's educational development programme was designed, not only as a social service providing the intellectual, moral and spiritual training of children for adult life, but also as an important part of an imaginative programme designed to lift the Maltese economy from its depressed state and increase the standard of living of her people.

It is clear from the very start that since the development of technical education was going to take some years, something must be done immediately to provide some sort of technical and industrial training for the unemployed—from whose ranks so many of the juvenile delinquents emerge—for prospective emigrants and to provide sufficient qualified technicians to carry out the five-year development programme.

With the co-operation of the International Labour Organization, which provided the technical advice and technical teachers and supervisors, and also the British Government, which provided a special grant of £400,000 out of the Colonial Development and Welfare Fund in addition to other funds, the Maltese Government started training courses in January 1956. An old tram depot was taken over and adapted, and since then a classroom block and new workshops have been added, with further accommodation being provided on the sister island of Gozo.

The original six-months course has been extended to ten months, and in the case of lads between sixteen and eighteen it is now being further extended to three years, to enable the boys to sit for examinations of a recognized high standard. Attendance is full-time, and an attendance allowance ranging between 30*s*. and 50*s*. a week is being paid. The training includes the teaching of theory and practice of each trade; in addition, English is taught.

The centres have already turned out 300 trainees, including a very valuable 150 electrical wiremen who were immediately absorbed by Government departments and private contractors on the changeover of the electricity distribution system—a project originally scheduled to take more than four years.

but now in process of being speeded up to be completed by the end of 1958. Most of the trainees have obtained good employment in Malta, or have emigrated.

At present there are 325 young men receiving full-time training in the following trades:

Course	Malta	Gozo	Total
Woodwork	45	24	69
Motor mechanics	45	15	60
Electrical installation	98	—	98
Plumbing	30	—	30
Painting	15	—	15
Sheet metal work	15	—	15
Plastering and tile-laying	15	—	15
Fitting and machining	13	—	13
Concrete supervisors	10	—	10
	286	39	325

Other courses are shortly being started for the training of agricultural workers and for women in homecraft, hotel duties, handicrafts, etc. In addition, a new scheme is being devised, in collaboration with the British Ministry of Labour, for the further practical training of trainees in factories in the United Kingdom.

Thus it can be seen that the whole of the Government education programme is designed to meet the economic requirements of the Islands, while providing for the individual and social development of young people, so that they can lead a fuller and richer life, either in Malta or overseas. The industrial training courses have given new hope to the youths who received only a bare primary education and then joined the ranks of the unemployed (and often became juvenile delinquents); as secondary education is developed, fewer youths will find themselves in the position in which the young men now enjoying these training courses were once placed: the position of being half-educated, unemployed or unemployable, frustrated and without any aim in life.

INTERNATIONAL CONGRESS OF PSYCHOLOGY

THE fifteenth International Congress of Psychology was held at Brussels during July 27–August 3, under the patronage of King Baudouin of the Belgians. The Congress was organized by the Belgian Society of Psychology under the auspices of the International Union of Scientific Psychology founded in 1951 at the thirteenth Congress, held at Stockholm. The Union has consultative status with Unesco, and now represents twenty-six national psychological societies. More than a thousand persons attended the Congress from some thirty countries, including about two hundred from the United States and many representatives from the U.S.S.R., Poland, Hungary, Czechoslovakia and Rumania. The homogeneity of the assembly was tempered by a sprinkling of neurologists, psychiatrists, physiologists, ethologists, educationists and philosophers.

Inaugural addresses were given by M. Léo Collard, the Belgian Minister of Education, Prof. Jean Piaget, president of the International Union of Scientific Psychology, Prof. Otto Klineberg, secretary-general of the Union, Prof. Albert Michotte, president of the Congress, and by Prof. Henri Piéron, of the Collège de France. These were followed by Prof. Michotte's presidential address, "Reflexions on the Role of Language in the Analysis of Perceptual Organization", in which he emphasized the importance of distinguishing, first, the verbal report given by an experimental subject; second, the experimenter's interpretation of this report; and third, the theoretical construction which the experimenter places upon his own interpretation. The relevance of this threefold distinction was illustrated by reference to Prof. Michotte's classical experiments on the 'pere ception of causality'. Evening discourses were delivered by Prof. Wolfgang Köhler on "Psychologi- und Naturwissenschaft", by Prof. Jean Piaget on "The Role of Models of Equilibrium in Psychological Explanation", and by Prof. Clyde Kluckhohn on "Psychology and Anthropology".

The programme consisted of symposia, individual papers and colloquia on some twenty-six themes. These included such traditional topics as phenomenology, the measurement of sensation, perception, learning, thought, emotion and conflict, motivation, the experience of space and time, biochemical influences on behaviour, brain and mind, and problems of psychological linguistics. The march of time—even in psychology—was recorded by the inclusion of such topics as non-parametric structural analysis, information theory and its psychological applications, and automation. Individual papers covered an even wider territory ranging from "The Impact of Education on Non-Scientific Beliefs in Ethiopia" to "Phantom Limbs". The three colloquia, to which selected participants were invited, were concerned respectively with the training of psychologists, terminology and co-operation with neuro-psychiatrists. Psychologists from universities and research and other establishments in Great Britain contributed their fair share to the proceedings. They took part in fifteen out of the twenty-four symposia and were responsible for organizing six of them.

Informal discussions between individual members of a congress can be at least as stimulating as listening to formal lectures, and apart from such informal discussions, there were opportunities for planning and co-ordinating new research. The meeting at Brussels made possible a multitude of invaluable exchanges of this kind and, of course, many new scientific contacts were established. One noticed particularly the keen mutual interest which psychologists from the United States and the U.S.S.R. expressed in work in their respective countries. Unfortunately, many American psychologists, especially those working in military establishments, do not seem to be in a position to propose making professional visits to research institutions in the U.S.S.R. A Russian suggested that they might overcome their difficulties by going as tourists.

It would be an invidious as well as an impossible task to single out the most noteworthy contributions, and I shall not here betray my own bias. Although the old 'schools of psychology' seem to be more or less extinct, psychologists are still sharply divided in the basic conception of their subject as well as in the nature of their work. Nevertheless, anyone with sufficiently broad interests could have profited from participation in most or even all the symposia. No epoch-making discoveries or Copernican revolutions appear to have been announced. Psychologists nowadays seem to be mostly content with modestly describing their day-to-day research, though some are wedded to theories of their own construction and

devote their lives to searching for data to fit them.

Something should be said about the wider problems of conducting a congress of this kind successfully, that is, in such a manner as to ensure that lack of familiarity with the language of the speakers, poor acoustics and administrative blind spots do not add to the task of communicating a highly compressed technical report in a short interval of time. No facilities for simultaneous translation of the papers were available because of the prohibitive cost. Consequently, a number of participants—how many it is hard to say—failed to appreciate the papers in spite of possessing a good reading knowledge of the languages in which the papers were delivered. So much so that a proposal was submitted to the president by one member that an investigation be undertaken of the intellectual effectiveness of the Congress. In these days when numerous international congresses are held in science, technology and medicine, the results of a study of this kind might well prove to be of widespread interest. Similar studies have been sponsored in the past by the World Health Organization and Unesco[1].

Many of those who had attended international congresses of psychology on previous occasions doubtless felt that the scientific quality of the contributions and discussions marked a distinct advance. The eccentric fringe which used to be attracted to international assemblies of psychologists was happily small; apart from one or two with highly characteristic opinions of their own, the mass of the members were indistinguishable from any other body of intellectual workers. All of them will recall with pleasure the reception at the Hôtel de Ville given by the Mayor of Brussels, and the paternal devotion lavished on them by Prof. Louis Delys, secretary-general of the Congress.

The Congress was preceded by a two-day international symposium on 'military psychology', held at the Palais des Académies and sponsored by the United States National Academy of Sciences and National Research Council at the request of the United States Air Force, Air Research and Development Command.

John Cohen

[1] "The Technique of International Conferences". *Internat. Soc. Sci. Bull.*, *5*, 231 (1953).

SOLVENT EFFECTS AND REACTION MECHANISM

For some years the Department of Chemistry of Queen Mary College, London, has organized symposia on the mechanisms of organic reactions. This year the specific topic of discussion was the effects of changes in medium on chemical reactions in solution. The meeting was held under the auspices of the Chemical Society on July 8 and 9. The title of the symposium was interpreted very broadly by both the organizers and the speakers, and the subjects ranged from organic chemists' investigations of reaction products to a thermodynamic treatment of solutions. Sixteen papers were read; eight of them came from the United States, seven from British laboratories, and one from a Swiss laboratory.

The first session, under the chairmanship of Prof. E. D. Hughes, was largely concerned with the mechanisms of organic reactions. The first paper, by Prof. P. D. Bartlett of Harvard University, dealt with the relation between reaction-rates and solvent properties in terms of the short-range interactions between solvent molecules and the reactants and transition states. Prof. Bartlett brought out very clearly the inadequacy of any treatment which considers only the bulk dielectric constant of the solvent, but showed how the kinetic effects of graded changes in solvent properties, for example, acidity or deuterium content, could sometimes be used as mechanistic criteria. The hydrolysis of β-lactones was discussed in this context. Discussing this paper Prof. W. F. K. Wynne-Jones pointed out that the kinetic effects of changes in bulk dielectric constant will be of considerable importance for solvents of low dielectric constant. He also gave examples of the effects of solvent changes on acid-base equilibria.

The nature of solvolytic reactions the behaviour of which may be intermediate between S_N1 and S_N2 was discussed by Dr. V. Gold of King's College, London, with particular reference to the ways in which solvent molecules can interact with the reaction centre. The range of the subsequent discussion showed that there is no unanimity of opinion on this particular problem. It appears that the original definitions of Hughes and Ingold are sometimes used rather loosely, and their appropriate application limits considerably the territory in this 'no-man's land' between the two clear-cut mechanisms.

Dr. E. M. Kosower of the University of Wisconsin described the dependence of the charge-transfer spectrum of some alkyl-pyridinium iodides upon solvent composition. This dependence could be used for calculating an empirical measure of solvent polarity, the Z value, which could be correlated with the rates of some solvolytic reactions. Evidence on the nature of the carbonium ion intermediates in reactions and oxygen exchanges of some alcohols and glycols was given by Dr. C. A. Bunton of University College, London. The carbonium ions may be captured by water molecules, regenerating the original alcohol, and this is observed in the elimination of olefins, and in anionotropic rearrangements.

The kinetic effects which deuterium substitution on a β-carbon atom has on nucleophilic substitutions and eliminations were described by Dr. V. J. Shiner of the University of Indiana, and various explanations of these effects, involving *inter alia* solvent interactions with the polarized C—H or C—D bonds, were considered. Discussing this paper, Drs. Halevi and Lewis gave further evidence for the thermodynamic and kinetic effects of deuterium substitution.

The mechanisms of solvolyses of carboxylic acid amides and esters in sulphuric acid were then discussed by Dr. R. J. Gillespie of University College, London. These compounds are fully protonated in this highly acidic solvent, and unimolecular mechanisms are facilitated, whereas in water and aqueous-organic solvents bimolecular substitutions are more common.

Prof. W. F. K. Wynne-Jones of King's College, Newcastle upon Tyne, was the chairman for the morning session of July 9. The first paper, by Dr. M. L. Bender of the Illinois Institute of Technology, was on the catalytic effect of Brönsted bases on the hydrolysis of esters and amides, and the evidence given showed that they acted as nucleophilic reagents by attacking the carbonyl carbon atom, creating entities which readily undergo further reaction. The catalytic power was much greater when these nucleophilic groups were already present

in the molecule, and it was suggested that this catalysis might occur in some enzyme-catalysed hydrolyses.

The next three papers dealt with the intimate details of the interactions between solvent and solute molecules. Dr. P. A. M. Wyatt of the University of Sheffield discussed the possibility of accounting for the properties of a solution in terms of a specific or 'chemical' solvation. He quoted as examples the thermal properties of solutions in sulphuric and nitric acids, and pointed out that, although solvation is important, other factors have to be considered, and that their nature is not well understood. Dr. J. W. Smith of Bedford College, London, showed how measurements of dielectric constant can give evidence for hydrogen-bonding in liquid mixtures, and how steric hindrance in aromatic amines could affect their interaction with solvent molecules. A semi-empirical treatment for the dependence of the rates of nucleophilic substitutions upon solvent properties was outlined by Dr. R. F. Hudson of Queen Mary College, London, who applied this treatment to the kinetics of alcoholyses of acyl halides in solvents of low polarity.

Spectrophotometric methods for investigation of carbonium ions in non-aqueous solvents were described by Prof. A. G. Evans of University College, Cardiff. His group has studied the formation of these ions from triaryl compounds, and it seems that there are specific interactions between the phenol molecules of the solvent and the carbonium ions. Similar measurements have been made on the carbonium ions formed by protonation of an olefin, or by the reaction between an alkyl halide and a metal halide. During discussion of this work Dr. R. H. Plesch suggested that these spectrophotometric measurements could be used to calculate approximate values for the solvation energies of carbonium ions.

The chair was taken by Prof. M. S. Newman of the University of Ohio during the afternoon session. An electrostatic theory for the kinetic effects of solvents was presented by Prof. E. S. Amis of the University of Arkansas, who suggested that the rates of many reactions could be correlated simply with the bulk dielectric constant of the solvents. Subsequent speakers showed that this simple electrostatic theory could not account for many of the complex solvent effects on rates and equilibria.

Dr. H. Zollinger read a paper by himself and Dr. O. A. Stamm on the kinetics of diazo-coupling reactions studied in the University of Basle. They found that kinetic salt and solvent effects could only be considered in terms of specific interactions between ions or solvent molecules and the groups present in the reactants. The authors were able to interpret the effects of Brönsted bases on the rates and chemical course of these reactions by considering their mechanistic details.

The first of two papers on solvent effects in non-polar reactions was given by Dr. J. E. Leffler of Florida State University, who outlined the form of the interactions between ions or solvent molecules and the reactants and transition states, and described a very detailed kinetic study of the rates of racemizations of a number of optically active diphenyls. Dr. G. A. Russell of the General Electric Corporation gave results on the photochemical chlorination of aliphatic hydrocarbons in conditions such that the first step of the reaction is the abstraction of a hydrogen atom from the hydrocarbon. It was possible to use the variation of product composition with changes in the solvent as evidence for the formation of a complex between an electrophilic chlorine atom and an aromatic hydrocarbon. In discussing this work Dr. W. A. Waters showed that while some free atoms and radicals had electrophilic properties others, such as sodium atoms, could act as nucleophilic reagents. The paper by Prof. L. F. Hatch and his co-workers described a re-investigation which they had made of the products of the addition of bromine to butadiene in various solvents.

The wide range of work discussed at this symposium shows the interest which chemists are taking in the effects of solvent composition upon rates and mechanisms. Understanding of the short-range forces which govern the interactions between solvent molecules and solutes during the collisions in which chemical reactions occur is now needed. It was therefore unfortunate that the recent work on nucleophilic substitutions in benzene, a solvent in which these interactions have been studied, was not one of the subjects under discussion.

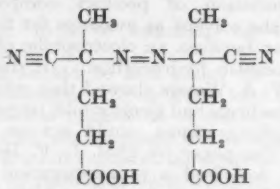
C. A. BUNTON

BLOCK AND GRAFT COPOLYMERS

CONTINUING earlier seminars on polymer science in the Chemistry Department of University College, London (cf. *Nature*, **178**, 18; 1956), five lectures on block and graft copolymers were given on July 15.

Prof. M. Szwarc (Syracuse University, New York) described experiments which show that anionic polymerization of certain vinyl monomers, such as styrene, carried out under appropriate conditions, does not involve a termination step (cf. Szwarc and collaborators, *J. Amer. Chem. Soc.*, **79**, 2026; 1957; and references to earlier communications given there). Polymers, formed in this manner, are able to continue their growth, if a fresh portion of monomer is added, after the complete conversion of the original monomer. If a monomer, *B*, is added to a block of 'living' polymer *A* . . . *A* a block copolymer is formed. The original polymer *A* . . . *A* may possess one or two 'living' ends, and therefore a variety of block copolymers can be prepared by relatively simple experimental techniques. The interaction of 'living' polymers with proton donors, carbon dioxide and oxygen was shortly discussed.

Dr. C. H. Bamford (Courtaulds, Ltd.) described a method for the preparation of block copolymers. A monomer, *A*, carrying a tertiary base residue, is converted into a polymer, *A* . . . *A*—C(Me)(N(Et)$_2$)—H, which is afterwards used as a macromolecular transfer agent in the polymerization of a second monomer, *B*. Chain transfer to the terminal group of the first polymer results in the formation of a block copolymer *A* . . . *A*—C(Me)(N(Et)$_2$)—*B* . . . *B*. In a second method for preparing block copolymers, use is made of the following chain initiator:



which leads to polymers containing terminal carboxyl groups. These latter species are coupled together by diols or other suitable bifunctional reagents. These two techniques were successfully applied for the preparation of block copolymers containing methylmethacrylate and either acrylonitrile or styrene. The composition and size distribution of some of these block copolymers could be calculated.

Drs. P. W. Allen, G. Ayrey and D. T. Turner (British Rubber Producers Research Association) gave lectures dealing with graft copolymers (I), made from natural rubber and polymethylmethacrylate. The copolymer (I) was prepared by the polymerization of methylmethacrylate, initiated by γ-radiation, this reaction being carried out in the presence of natural rubber. The influence of the purity of the natural rubber and of the methylmethacrylate, field intensity, concentration of methylmethacrylate and other variables on the rate of formation, yield and structure of the copolymer (I) were investigated. An alternative method of preparing the copolymer (I) consists in the benzoylperoxide initiated polymerization of methylmethacrylate, this process being again carried out in the presence of natural rubber. If azoisobutyronitrile is used as initiator, polymethylmethacrylate is formed, but no copolymer (I). The cause of this specific initiator effect and some aspects of the mechanism have been investigated by using initiators labelled with carbon-14. In these investigations the separation of copolymer (I) from the natural rubber and methylmethacrylate was carried out by fractional precipitation, fractional extraction and turbidimetric titration methods. For purposes of characterization of (I) its molecular weight was determined, and after degradation of the rubber component with ozone, the molecular weight of the remaining polymethylmethacrylate component was measured.

ELECTRONIC INSTRUMENTS EXHIBITION, MANCHESTER

THE Institution of Electronics is a nation-wide organization, but its headquarters are now in the north of England and its main centre of activity is Manchester, where the exhibition of electronic instruments organized by the Northern Division has, since the War, become established as an annual event. The twelfth annual Electronics Exhibition and Convention was held during July 11–17 at the Manchester College of Science and Technology. About sixty manufacturers and other organizations exhibited their products, and the Exhibition was attended by about 14,000 visitors. Most of the exhibits consisted of commercially available equipment, which was in some cases shown in action, and there was also a special section for equipment still in the research stage. A programme of lectures and films ran concurrently with the Exhibition, and these were well attended.

Earlier Exhibitions have included a number of sections which would appeal to a wide public—for example, sound-reproducing equipment and electronic musical instruments. However, these were absent from this year's Exhibition, which was clearly aimed, even more than usual, at the professional user, and perhaps the manufacturer, of electronic instruments. For the latter, components and even such things as racks and chassis were shown by several firms. The Exhibition included an impressively wide range of instruments, of which a few only, a personal selection, can be mentioned. There was, in any event, little that was really new, although there were some items which had appeared since last year's Exhibition.

A flying-spot microscope which was shown by Cinema-Television, Ltd., is fitted with arrangements for counting the number of particles in its field, and their size distribution is obtained by successive counts with different adjustments of a size discriminator. A magnetic 'memory' in the counting unit ensures that a particle large enough to be scanned on several successive lines is only counted once: this is only defeated by particles the shape of which is re-entrant in the scanning direction, or perforated.

Another exhibit by Cinema-Television, Ltd., was a photographic contact printer designed to produce satisfactory contact prints from patchy negatives. A rather large spot of light from a cathode-ray tube scans, raster-wise, the negative with the printing paper in contact. The light passing through them both falls on a photocell the output of which is used to produce limited variations in the brightness of the spot. The broad scanning lines produced by the large spot overlap considerably, so that the definition is that of the negative and no scanning lines appear on the print. The instrument, in fact, carries out automatically the hand-shading usually employed in the printing of uneven negatives. Its cost, more than £900, will presumably limit it to large-scale users, and examples were given of its use in connexion with aerial photography and the commercial printing of amateurs' negatives. Another version which will make enlargements is to be produced.

An exhibit which was at least new to these Exhibitions was a version of the Land camera made by Langham Thompson, Ltd. In its present form it is intended for photographing cathode-ray tube displays and is fitted with an $f/3{\cdot}5$ lens and a single-speed shutter. The novelty is that instead of film it uses special photographic paper with pods of developing and fixing chemicals attached to it at regular intervals. When the paper is wound on after exposure, rollers burst one of the pods and the chemicals are spread on the paper while it is still inside the camera. After waiting for one minute the paper is pulled out and emerges as a finished positive print. The material available is very fast (35° Scheiner) and some twice as fast is promised soon. The operating cost is about 2*s*. 6*d*. a print (4 in. × 3 in.).

Of the many cathode-ray oscilloscopes on show, the most novel were probably those by Cossor, Ltd., which are available only as kits of parts, but at little more than half the cost of comparable finished instruments. They use printed circuits throughout, and the made-up samples on show were clean-looking jobs—in fact, one suspects that the relative absence of wiring will greatly reduce the tangled web which sometimes results from amateur construction, as well as making the circuit characteristics more predictable.

Three kits are at present available, for single-beam and double-beam oscilloscopes and for a valve voltimeter.

Several counting and scaling units were shown—one which provided some relatively light relief was arranged to measure one's reaction time. The victim was required to press a button when some miniature traffic lights turned red. The time taken in micro-seconds was duly counted and displayed; it was usually of the order of 2×10^5.

The research section showed a change from previous years in that there were no university exhibits, but three by national organizations: the Admiralty, Atomic Energy Research Establishment, Capenhurst, and the British Railways Research Department. The last-named was showing a train control system which automatically applies the brakes of a train passing a signal at danger. The Hall effect in an indium antimonide probe attached to the train is used for detecting the energization of an electro-magnet between the tracks. This equipment, which is still in the experimental stage, is intended as an all-electronic successor to the electro-mechanical system now going into service. J. E. GEAKE

ENGINEERING TRAINING IN THE BRITISH BROADCASTING CORPORATION

THE series of B.B.C. Engineering Monographs, to which reference has already been made in *Nature* (177, 519; 1956), provide a continuous description of the technical equipment and operation of the Corporation, developed and applied to the conduct of its duties as a public broadcasting authority. Among these duties is that of recruiting and training the large numbers of engineers and technical personnel required by the organization.

B.B.C. Engineering Monograph No. 11* is entitled "Engineering Training in the B.B.C.", by Dr. K. R. Sturley, and this describes the work of the training department which came into existence about eleven years ago, and is established at Wood Norton Hall, Evesham. Here there is accommodation for up to two hundred residential students, and full teaching facilities during various courses of instruction, which vary in length from one or two up to twelve weeks. The aims of the training department are to develop the skill and capabilities of staff, to encourage them to adopt a constructive attitude to new ideas and to increase the efficiency of the individual to the mutual benefit of himself and of the organization to which he belongs. Every attempt is made to avoid duplicating the basic training in electrical engineering which is provided by universities and technical colleges; the department concentrates on the application of basic principles to the equipment and methods used in broadcasting.

Some of the courses provide training for newly recruited entrants to the operating and technical assistant staffs, where the instruction varies from the arrangement of studio lighting to the maintenance of high-power transmitters. More advanced courses are intended to provide junior staff with opportunities for promotion in the operations or maintenance fields. Students with the appropriate national technical qualification may be exempt from the first part of this course; they are then required to take the second part, dealing with broadcasting equipment and technique which cannot be a part of the syllabus leading to an academic award. At a more advanced level there is a graduate apprentice course of two years duration, involving attachment to other departments of the B.B.C. as well as the training department. Its purpose is to produce a well-balanced man of wide experience, who will eventually qualify for corporate membership of his appropriate professional institution. Two types of graduates are sought here: one intended for specialist departments such as those conducting research or design and development; the other is intended to fill a senior position in the operation and maintenance branch, where the ability to supervize staff and to deal coolly and efficiently with an emergency are essential qualities.

Under Dr. Sturley as head of the Training Department, the instruction is organized in four sections dealing with fundamentals, radio-frequency transmission, studio and recording techniques, and operations; a fully qualified staff of lecturers, demonstrators and laboratory assistants is provided. A separate section of staff is responsible for the production of training manuals, and also of booklets on such subjects as television lighting, frequency modulation and slot aerials, which are of great value to the technical staff of the Corporation.

During July 22–26 last, a summer school was held at Wood Norton and was attended by some thirty members of the staffs from the engineering and physics departments of universities and technical colleges in the United Kingdom. In addition to inspecting the Training Department and witnessing demonstrations in the laboratories, a series of lectures was given by members of various departments of the B.B.C., the subjects ranging from training, research and operation to the presentation of science in sound and television broadcasting. The programme naturally included talks on the engineering and technical requirements of the B.B.C. staffs, and there was ample opportunity for both formal and informal discussion between the visitors and the resident staff. This short and very successful summer school, which was a repetition on an expanded scale of one held in 1952, should do much to strengthen the ties between the Corporation and the colleges on which it must rely for its recruits.

TRAINING OF FACTORY WORKERS

THE effectiveness of the training of factory workers has an important bearing on industrial productivity. Developments of production methods in this century, particularly in some of the newer industries, have made it possible to employ large proportions of semi-skilled and unskilled workers in the factories; the training of this kind of operative has been relatively neglected until recent years, presumably on the assumption that, because his work was simple in comparison with that of the craftsman, he would be able to learn it with a minimum of assistance.

* B.B.C. Engineering Monograph No. 11: Engineering Training in the B.B.C. By Dr. K. R. Sturley. Pp. 24. (London: British Broadcasting Corporation, 1957.) 5s.

That this is an unwise policy to follow has been demonstrated by the experience of firms which have set about the training of semi-skilled and unskilled workers in a systematic fashion, endeavouring to teach them the knowledge and the skills they have to acquire in order to carry out their work effectively. In order to encourage industry to recognize the importance of the subject and to help managers with information on the training of operatives, the European Productivity Agency sponsored a survey in seven European countries. The aim of the survey was to study current practice in the systematic training of operatives within the factory itself.

The organization responsible for the survey in Britain was the National Institute of Industrial Psychology, which was also made responsible for co-ordinating the whole inquiry and preparing a report*.

The survey made it abundantly clear that, as yet, industry in general has done very little to provide training for semi-skilled and unskilled workers on a systematic basis. The situation differs from industry to industry; it was easier to find examples of systematic training in the textile and clothing industries, in the electrical and transport equipment industries and in the chemical industry than in others.

The fact that systematic training is so little developed reflects the attitude of managers to the question of training for the kind of work with which the inquiry dealt. This attitude seems to stem from a number of ideas, to four of which reference was most frequently made.

The first was that semi-skilled and unskilled jobs were so simple that they could easily be learned without any training. Secondly, there was the fear that workers who were trained would be enticed away to other firms, perhaps at higher wages. An associated idea was that, because the rate of labour turnover was high, it was not worth while attempting to improve the training of the new workers. Lastly, there was the notion that systematic training is necessarily elaborate and expensive. This stems from the lack of information on training methods and their applicability to different kinds of situation, with their relative advantages and disadvantages.

There were, however, some managers who considered that they had a social responsibility for ensuring that their employees were helped to acquire the knowledge and the skills needed for the successful execution of their work. Some took a still wider view of their responsibilities: it was not, they felt, enough for industry to help the individual to develop his professional skill; it should provide him with opportunities and assistance for developing general knowledge and character qualities which would help him to lead a fuller and more satisfying life.

Although no evaluation of training schemes was possible because firms were not in a position to provide the evidence on which such an evaluation could be based, it was the almost unanimous opinion that the results were beneficial.

The survey also demonstrated the general applicability of systematic training methods in factories. Not only were the learners of all ages, but also the range of unskilled and semi-skilled jobs for which training was being given was a very wide one, from tasks as simple as machine feeding or packing articles in boxes to others like weaving and loom maintenance, where both the knowledge and the skill involved can be extensive.

In all countries the investigators reported a tendency for training schemes to be weaker on the side of instructional method than on that of organization. In many cases those who gave the instruction to the novices had not themselves received any training in the art of instruction. Although success in instruction is largely dependent on the personality of the instructor and his interest in the job, skill in instruction can be developed by formal training, and an increase in facilities for such training will be required in all the countries concerned as the systematization of training of semi-skilled workers is extended in industry.

* The Training of Workers within the Factory. Pp. 90. (European Productivity Agency for the Organization for European Economic Co-operation, 1957.) 6s.

COLONIAL TERRITORIES

REPORT FOR 1956–57

THE report on the Colonial territories for 1956–57* follows the pattern of previous years, providing the conspectus of political, economic, financial and social developments in these territories against which the achievements to be recorded in greater detail in "Colonial Research, 1956–57" are to be considered. Some of this material, outlined in the chapter entitled "Research and Surveys", has also appeared in reports from various Colonial research organizations already noted in *Nature*, and for this reason, although this chapter of the present report is that of most direct interest to the scientist, consideration of research in the Colonial territories will be deferred until the fuller report on "Colonial Research, 1956–57" is published in due course.

Recruitment to the Overseas Civil Service was maintained generally at the level of previous years. Almost the same number of electrical and mechanical engineers were recruited as in 1955, and recruitment of civil engineers improved; that of agricultural officers fell. Demand remained high for all these appointments, and there was little change in the number of unfilled vacancies. Those in the service of Colonial governments who received training in the United Kingdom reached a record number of 2,752, compared with 2,190 in 1955 and 2,081 in 1954.

Outputs of most products rose in 1956 and it is estimated that the gross domestic product at market prices in the Colonial territories was some 4 per cent higher than in 1955. Increases in cocoa production in both the Gold Coast and Nigeria largely compensated for the lower prices. In 1956 roughly half the United Kingdom's imports of hardwoods came from the Colonial territories. A new copper smelter and textile plant were opened in Uganda, and a large expansion in bauxite production is planned in Jamaica and British Guiana. The value of Colonial exports was about 6 per cent higher than in 1955 and the value of imports rose by 9 per cent, the general pattern of Colonial trade showing little change.

Two new irrigation schemes have been inaugurated in Tanganyika, and progress is being made on three major irrigation projects in Kenya and in the exploitation of the limited water resources of Cyprus, while effect has been given to a scheme to establish an agricultural tractor and implement testing unit in

* The Colonial Territories, 1956–1957. Pp. xxv+185. (Cmnd. 195.) (London: H.M. Stationery Office, 1957.) 7s. net.

East Africa. Planning to ensure that the most suitable use is made of land is receiving much attention, and in the Gold Coast the swollen shoot campaign continued vigorously. Up to August 1956 more than 14 million acres of land, including 4 million acres of cocoa, had been extensively surveyed in this campaign, and spraying by farmers against capsid made good progress. Spraying against black pod in Nigeria is being intensified, and the acreage lost through cutting out in the campaign there against swollen shoot has been more than made good by new planting. A campaign in Cyprus against the Mediterranean fruit-fly is estimated to have resulted in savings of more than £250,000 in citrus fruit.

Good progress was again made in the execution of development and welfare schemes, expenditure on which rose to just over £17 million, with a further increase of about £26 million in the value of schemes approved during the year. Most Colonial governments have now drawn up plans for the current quinquennium, and it appears that Colonial governments and other public bodies plan to spend £150 million a year on development over the next few years, of which it is hoped to raise £30 million annually from external loans; about £15 million a year from Colonial Development and Welfare funds; and £15–20 million a year from local loans. The continued slump in world prices for cocoa was reflected in a further decline in Gold Coast Government revenues, resulting in curtailed funds for development and a call for economies in day-to-day expenditure, and in East Africa there was a marked fall in revenue from import duties; elsewhere there were no significant changes in the trends of revenue and expenditure. Encouraging increases continued in the volume of air traffic within, to and from the territories, and as a result of the resolution on the need for research in tropical meteorology passed by the 1955 Conference of Commonwealth Meteorologists, arrangements were made for a survey of the research requirements for tropical meteorology, by Dr. A. E. Forsdyke, of the British Meteorological Office.

Of the 4,858 students in the three universities and four university colleges of the Colonial territories, 1,574 were in the University of Malaya, 941 in the University of Hong Kong, 625 at Makerere College and 609 at University College, Ibadan. While these institutions continued to rely mainly on the United Kingdom for new staff, increasing numbers of local candidates were becoming qualified for teaching and administrative posts, and seven promising young Colonial graduates went to universities in the United Kingdom to fit themselves for teaching posts in their own colleges and universities. The Royal Technical College of East Africa, which opened in April, had 250 students for its first full session in October, the Kumasi College of Technology had 607 students and the Nigerian College of Arts, Science and Technology 549.

The emphasis placed on preventive medicine in recent years is reflected in a more stable balance in health programmes, with the community and social approach absorbing a fair share of departmental resources. The pattern of morbidity is veering away from the preponderance of tropical endemic disease to something more akin to disease-incidence ratios in temperate climates and, with the exception of malaria in hyperendemic areas, most of the parasitic diseases are coming under firmer control, tuberculosis now causing most general anxiety. Mass campaigns against yaws have met with notable success; but although 142 doctors were appointed to Medical Departments in 1956 through the Colonial Office, there were 135 vacancies outstanding at the end of the year. There were no widespread epidemics of the major acute communicable diseases, and in several non-tropical territories there are signs that tuberculosis is being successfully controlled. Recruitment of qualified nurses from the United Kingdom was maintained steadily throughout the year, but vacancies were only decreased from 165 to 102, and the acute shortage of nursing and midwifery tutors is causing anxiety. The training of nurses is still being given the highest priority in all territories. In June the Rockefeller Foundation made a grant of £17,000 to the London School of Hygiene and Tropical Medicine for research into the protein value of tropical dietaries and supplementary foodstuffs.

Of the 12,622 Colonial students in the United Kingdom and Irish Republic, 3,170 were scholarship holders and 3,365 were at universities; 1,295 were studying engineering; 1,075, medicine; 357, science; 308, economics; 117, agriculture; and 112, dentistry. Technical assistance projects in the Colonial territories under the United Nations Expanded Programme of Technical Assistance are estimated to cost 1,271,000 United States dollars in 1957, compared with 1,079,000 dollars in 1956. The report notes that the British teams participating in the international campaign against the desert locust in the Arabian peninsula were requested by the Government of Saudi Arabia to leave the country, and all personnel and equipment have been withdrawn.

UNIVERSITY GRANTS COMMITTEE

RETURNS FOR 1955–56

THE annual returns from universities and university colleges in receipt of Treasury grants for the academic year 1955–56, published by the University Grants Committee*, records an increase of 3,489 in the number of full-time students, which now stands at 85,194, compared with 81,705 in 1954–55, 80,602 in 1953–54 and 81,474 in 1952–53, and it is expected that the number in 1956–57 will show a further and greater increase as the number of full-time students in the autumn term of 1956 was 4,623 greater than in the autumn term of 1955. In the English universities, full-time men students increased by 1,997 and women by 714; for Wales, the corresponding figures were 71 and 61; and for Scotland, 400 and 246. There were 5,536 full-time and 2,068 part-time students from overseas within the British Commonwealth, and 3,750 full-time and 1,756 part-time students from foreign countries; for 1954–55 the corresponding figures were 4,987 and 2,010 for the Commonwealth and 3,617 and 1,594 for foreign countries. Distribution of full-time students among the faculties showed no significant change, an increase from 17,327 to 18,133 in students of pure science representing from 21·2 to 21·3 per cent of all students, and an increase from 10,586 to 11,379 in students of technology, representing 12·9 to 13·3 per cent of the

* University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1955–1956. Pp. 50. (Cmnd. 211.) (London: H.M. Stationery Office, 1957.) 3s. 6d. net.

total numbers. Full-time advanced students of pure science numbered 3,399 (34·6 per cent); of technology, 1,538 (15·6 per cent); of medicine and dentistry, 1,015 (10·3 per cent); and of agriculture, 322 (3·3 per cent); 2,832 students were working for the teacher's diploma. Of the full-time students, 67,850 were reading for a first degree, 4,021 for a first diploma, and 12,668 were engaged in research or other advanced work, the corresponding figures for 1954–55 being 64,778, 4,099 and 12,212.

The proportion of assisted students was 74·9 per cent, compared with 72·9 per cent in 1954–55 and 71·9 per cent in 1953–54; for England as a whole this proportion increased from 74·9 to 76·8 per cent; for Scotland it increased from 59·5 to 62·2 per cent; and for Wales increased from 86·6 to 88·5 per cent. For the English universities and university colleges, excluding Oxford, Cambridge and London, 83 per cent were assisted students. The dependence on parliamentary grants was unchanged, the £26,986,519 received in 1955–56 again representing 70·4 per cent of the total income, that from fees increasing from 10·7 to 11·2 per cent, and payments for research from 5·5 to 6·0 per cent. Endowments represented 4·0 per cent, grants from local authorities 2·9 per cent and donations and subscriptions 1·0 per cent; for 1954–55 these figures were 4·1, 3·2 and 1·1 per cent, respectively. The ratio of staff to students continued to improve, the full-time teaching staff now numbering 10,202, compared with 9,810 in 1954–55.

Of the full-time students, 65,779 were in England (15,474 at Oxford and Cambridge, 19,029 at London), 4,626 in Wales and 14,789 in Scotland. Except for King's College, Durham, where the position was unchanged, the increase in students was distributed over all the universities and university colleges, approaching 10 per cent at Nottingham and Southampton. The proportion of full-time students living in colleges and halls of residence decreased to 27·5 per cent, although the total (23,415) was higher. Of those in residence, 8,110 were at Oxford and Cambridge, 12,186 at other English institutions, 1,268 in Wales and 1,851 in Scotland. The proportion of men in residence was 23·3 per cent and of women 40·1 per cent; whereas 38,072 students (44·7 per cent) were in lodgings and 23,707 (27·8 per cent) at home, compared with 42·3 and 29·3 per cent, respectively, during the previous year. Of the 23,990 students admitted for the first time in 1955–56 (an increase of 6·8 per cent on the previous year), 22,414 were reading for a first degree and 1,576 for a first diploma; of those reading for a first degree, 1,572 were less than eighteen years of age and 12,317 were nineteen or more. Of the full-time students, 37,897 out of 49,790 men and 12,534 out of 15,989 women in England were receiving assistance by way of scholarships, exhibitions or other awards from public or private funds; for Wales, the corresponding figures are 2,866 out of 3,528 men and 1,228 out of 1,368 women; and for Scotland, 6,784 out of 10,715 men and 2,421 out of 4,074 women. Of the 63,763 full-time men students, 36 per cent were in arts, 22·2 per cent in pure science, 16·3 per cent in medicine and 17·6 per cent in technology; for the 21,431 women students, the corresponding percentages are 64·0, 18·4, 13·8 and 0·7, respectively. Medicine and dentistry claimed 51·1 per cent of the part-time advanced students, arts 35·1 per cent, pure science 9·5 per cent, and technology 3·4 per cent, compared with 52·2, 34·9, 9·2 and 2·7 per cent, respectively, during 1954–55.

The recurrent income of the universities and university colleges of Great Britain increased by £2,716,573 to £38,316,651, and in addition to the recurrent grant of £26,986,519 included in this total, the universities received from the Treasury in 1955–56 non-recurrent grants totalling £7,084,366 in respect of capital expenditure. Of the recurrent expenditure of £38,038,270, an increase of 9·3 per cent on 1954–55, 7·0 per cent was spent on administration, 69·1 per cent on departmental maintenance, 12·3 on maintenance of premises, miscellaneous expenditure amounting to 10·5 per cent. The largest increases were in departmental wages (technicians and laboratory assistants) amounting to 14·6 per cent, and in repairs and maintenance of buildings, at 14·7 per cent. Expenditure on libraries (excluding general maintenance of such buildings) increased from £1,352,244 to £1,468,512. Statistics for the expenditure on the libraries of individual universities and university colleges included in the tables of comparative statistics again show how far such provision is from being adequate to meet existing needs, quite apart from coping with the expansion now beginning.

POLAROGRAPHIC WAVE ANALYSIS

By Dr. D. C. MUNRO

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A POLAROGRAM—the plot of current against potential for a cell consisting of a reference anode and dropping mercury cathode—is most frequently constructed for determination of the diffusion current and hence of the concentration of some molecular or ionic species in the solution surrounding the dropping electrode. The half-wave potential for the reduction wave may also serve to characterize the reducible species. Less commonly, the shape of the wave has been used for determining the number of electrons involved in the reduction process taking place at the dropping electrode. A method is now described for determination of the electron number of the electrode reaction by direct measurement of the wave slope, and without the laborious graphing procedure used hitherto.

When reactions at the electrode surface are reversible, the shape of a polarographic reduction wave is described by the equation put forward by Heyrovsky and Ilkovic[1]

$$E = E_{1/2} - \frac{RT}{nF} \ln \frac{I}{I_d - I}$$

($E_{1/2}$ represents the half-wave potential in volts, I is the current at any point on the wave, and I_d is the final diffusion current.) Such waves have been analysed by plotting $\log I/(I_d - I)$ against E for points on the wave, and the number of electrons is

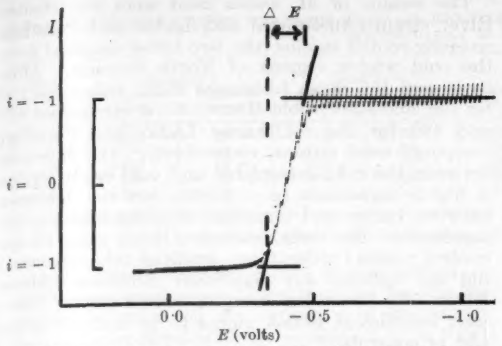

Fig. 1. Polarogram from a 4×10^{-3} M solution of thallous ion in molar tartaric acid. Construction lines show the three tangents and the significance of the potential increment (ΔE). The scale shows the current parameter i

determined from the slope of the line so obtained. The accuracy of this measurement is restricted by such factors as drop oscillations, differences in diffusion coefficients of reduced and oxidized species, and slow rates of reaction at the electrode surface.

For the greater part of the current increase, a normal polarographic wave approximates closely to the tangent at the half-wave point; and values of E and I for the graphing procedure are mainly taken from this portion of the wave, which is nearly linear. The equation of this tangent is most readily found in terms of a current parameter i, which is the difference between the current at any point and that at the half-wave point, expressed as a fraction of half the final diffusion current.

$$i = \frac{I - \frac{1}{2}I_d}{\frac{1}{2}I_d}, \text{ so that } \frac{I}{I_d - I} = \frac{1 + i}{1 - i}$$

At the commencement of a wave $i = -1$; at the half-wave point $i = 0$; and on completion of the wave $i = +1$. In the equation due to Heyrovsky and Ilkovic, the logarithmic terms may be expanded.

$$\ln \frac{1 + i}{1 - i} = 2\left(i + \frac{i^3}{3} + \frac{i^5}{5} + \frac{i^7}{7} + \ldots\right)$$

At the half-wave point, where $i = 0$, the tangent to the wave is described by the equation: $E = E_{1/2} - 2iRT/nF$. From the commencement of the wave ($I = 0$, $i = -1$) to the completion of the current increase ($I = I_d$, $i = +1$), the potential increment (ΔE) described by this tangent is $-4RT/nF$ volts; at 18° C., $\Delta E = -0{\cdot}1003/n$ volts. Thus the electron number of the reduction process is inversely proportional to this potential increment.

Fig. 1 shows a polarogram obtained from a solution of thallous ion, 4×10^{-3} M in molar tartaric acid. Construction lines illustrate the significance of ΔE, and the current parameter i.

The most satisfactory method for measurement of electron number is to compare the potential increment over a wave with that measured similarly for a reduction of known electron number, for example, that of thallous solutions. This procedure tends to compensate for errors in the drawing of the half-wave tangent.

Ion	ΔE (volts)	$\Delta E n/\Delta E$
Tl^+	0·120	1·0
Pb^{2+}	0·066	1·8
Bi^{3+}	0·043	2·8

The validity of this procedure is indicated by the tabulated results, which were obtained from measurements on solutions, in molar tartaric acid, of Tl^+, Pb^{2+} and Bi^{3+}, each approximately 4×10^{-3} M.

[1] Heyrovsky, J., and Ilkovic, D., *Coll. Czech. Chem. Com.*, **7**, 198 (1935).

ELECTRICAL DETERMINATION OF COLD HARDINESS IN *TRIFOLIUM REPENS* L. AND *MEDICAGO SATIVA* L.

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THE determination of cold hardiness, or conversely cold injury, is of considerable interest to plant breeders. The aim of our investigation has been to develop a rapid technique which can be used for establishing differences in cold hardiness between strains and between individual plants, particularly of certain forage legumes.

By cold hardiness we understand the ability of a plant or strain to withstand temperatures below freezing point with minimum subsequent injury. In spite of the work that has been done on the subject, no physiological test is currently in use for determining differences in cold hardiness between plants of the same variety or strain. The test devised by Dexter *et al.*[1] appears to be useful only for determining differences between strains. At present, survival after freezing is used as the criterion of hardiness in breeding programmes[2,3]. We use the term 'cold hardiness' rather than 'cold resistance' so that we can use the term resistance to mean electric resistance.

The subject of cold hardiness was reviewed by Levitt[4], who points out: (1) there is more than one kind of cold injury; (2) cold hardiness depends on the season; (3) there are several independent Mendelian factors responsible for cold hardiness; (4) hardy plants often possess relatively small cells; and (5) the factors of hardiness and small cell size can be separated by breeding. These facts have been kept in mind for the following investigation. In particular, we have been concerned with developing a method for measuring total injury resulting from a suitable cold treatment, rather than with measuring one or more factors responsible for cold hardiness.

Work on the determination of injury caused by poisons[5] suggested that the same test should be satisfactory for determining frost injury. The tissue under test is impaled on two needle tips (for example, 1½ mm. long and 5 mm. apart), and the electric resistance of the tissue is then measured at 1 kc./s. (R_{LF}) and at 1 Mc./s. (R_{HF}). The electrical resistance index $R_{LF}/R_{HL} \times 100$ is taken as the criterion for injury; as was shown in the course of the present experiments, the magnitude of this index decreases with increasing period of freezing or with increasing severity of freezing, becoming approximately 100 at death. The

Table 1. Mean Resistance Index Values for Ecotypes of *T. repens*, with and without Cold Treatment

Population	Character	Exp. 1 (treated)	Exp. 2 (treated)	Exp. 3 (treated)	Exp. 4 (untreated)
Mediterranean	Cold susceptible	130†	240†	300†	730*
N. European	Cold hardy	630	690	790	800

Above values are means for 6–8 plants. The variation in mean values from experiment to experiment is attributable to variations in the rate of cooling of the refrigerator

* Significantly less than value vertically below it ($p < 0.05$)
† " " " " ($p < 0.001$)

arithmetical factor of 100 is included in the index for convenience.

Luyet[6] showed that in sliced healthy tissues, R_{LF} was considerably greater than R_{HF}, and that R_{LF} decreased with increasing injury, until at death it had approximately the same value as R_{HF}. However, he did not suggest the ratio of R_{LF}/R_{HF} as a criterion of vitality, or conversely of injury. The rationale behind this ratio as the criterion is that in healthy cells the impedance of the plasmalemma is mainly responsible for the high values of R_{LF}, but has essentially no influence on the magnitude of R_{HF}. With increasing injury the impedance of the plasmalemma falls and becomes negligible, affecting the magnitude of R_{LF} but not of R_{HF}. Advantages of using the ratio R_{LF}/R_{HF} in the above index are: (1) variations in R_{LF} are found to be at least partially compensated for in the same plant sample by corresponding variations in R_{HF}; (2) the magnitude of the ratio or index is essentially independent of cell size and therefore of the number of cells between the probe tips.

Distinction between ecotypes or strains. The material for test was selected from non-winter-hardy and winter-hardy ecotypes or strains of *T. repens* and *M. sativa*. The plants were grown under field conditions at Canberra, and measured during winter. They were removed from the field, the roots were cut off 4 in. below, and the stem 2–3 in. above, the plant crowns. Plant material thus prepared was given a pretreatment of 2 hr. at 2° C., was left for 8 hr. at − 8° C. in a refrigerator, then for one hour at − 2° C., and then kept in sealed vessels at 20° C. for 17 hr. before measurement with the apparatus described by Greenham[5]. Control material was kept at 20° throughout, without any freezing treatment. Four readings were made on each crown of *T. repens* and six to eight measurements on each crown of *M. sativa*. The mean value for each crown was used for statistical analyses. The measurements were made on the crowns as that material was the least variable.

Measurements were made on ecotypes of *T. repens* from extreme geographical regions of Europe. Table 1 shows that, for the treated plants, the mean for a Mediterranean population is significantly less than that for a north European population ($p < 0.001$).

We interpret this as showing that the former populations were more injured than the latter. Moreover, Table 1 shows that a slight but significant difference in resistance index value can occur between ecotypes exposed to frost in the field during winter in Canberra. At this stage we cannot say if this difference is due to frost injury in the field.

The strains of *M. sativa* used were the Hunter River strain (Australian) and Ladak and Canadian creeping-rooted strains, the two latter obtained from the cold winter regions of North America. After treatment the mean resistance index value was 200 for the cold-susceptible Hunter River strain, and 470 and 480 for the cold-hardy Ladak and Canadian creeping-rooted strains, respectively. The difference between the cold-susceptible and cold-hardy strains is highly significant ($p < 0.001$), but the difference between Ladak and Canadian creeping strains is not significant. The mean resistance index value for the control plants (without any artificial cold treatment) did not indicate any significant difference (Hunter River 523, Canadian creeping-rooted 566). There were insufficient Ladak plants to be included in the test of controls.

We therefore conclude that the resistance index method can be used for the rapid discrimination of cold-susceptible and cold-hardy strains (two assistants can measure 120 plants in 8 hr.). A particular convenience of the test is that after measurement the crowns can be planted out to test for recovery.

A note may be added concerning the claim that the strains or ecotypes used are cold-susceptible or cold-hardy as has been indicated above. From the nature of their original climates, there is every reason to regard the north European populations of *T. repens* as considerably more cold-hardy than Mediterranean populations. Moreover, it is reasonable to expect a correlation between the cold-hardiness of the crowns and that of the stolons. In fact, the cold-treated stolons of the plants used for Table 1 were planted out after the test on the crowns. More than 50 per cent of the twenty stolons from the treated north European population recovered, whereas none of the twenty-two stolons from the treated Mediterranean population recovered. Other experiments have shown that there can be 80–100 per cent recovery from any untreated population (even with untreated plants, a few may not recover from being transplanted).

As regards *M. sativa*, the Hunter River strain was derived from the very cold-susceptible Provence strain[7], and has been continuously grown in the mild winter region of Australia. The cold-hardiness of the Ladak and Canadian creeping lucerne has been described by Heinrichs[8]. In addition, we have found by the Dexter test that the Hunter River lucerne is more injured by cold treatment than either of the two Canadian strains ($p < 0.001$) and that there was no significant difference between the Canadian strains.

Effect of increasing cold treatment and distinction between individual plants. The material (*T. repens*) was dug from five different localities at Mt. Kosciusko, all within a radius of a few miles and as close as possible to snow. The material was brought to Canberra in paper bags in a metal container. Material from each locality was divided into five different groups, four of which were given the same pretreatment as before and then subjected to − 6° C. for 1, 2, 4 and 8 hr. (the 0 hr. groups were kept in sealed jars at 20° C. and had no pre-treatment). After treatment, measurements as described previously were made on the stolons and also on the crowns when present and large enough (the plants varied considerably in size). After measurement, the stolons or stolons with crowns attached were planted out and checked for recovery five weeks later.

Table 2. CORRELATION BETWEEN RESISTANCE INDEX AND RECOVERY AFTER VARIOUS COLD TREATMENTS APPLIED TO STOLONS OF *T. repens* (APPROXIMATELY 50 PLANTS PER LOCALITY)

Treatment (hr. at −6° C.)	Locality 1		Locality 2		Locality 3		Locality 4		Locality 5	
	Mean index	Survival (per cent)	Mean index	Survival (per cent)	Mean index	Survival (per cent)	Mean index	Survival (per cent)	Mean index	Survival (per cent)
0	860	80	740	90	890	100	630	90	730	90
1	730	44	740	75	750	75	630	56	720	67
2	420	40	640	30	440	25	330	11	460	40
4	390	0	330	22	250	11	200	0	250	0
8	240	0	310	10	170	0	180	0	140	0

Treatment effect highly significant ($p < 0.001$). Location effect significant ($p < 0.05$)

An analysis of variance (Table 2) was carried out on the stolon resistance index readings for the five populations subjected to various cold treatments. The treatment effect is highly significant ($p < 0.001$) and the location effect is also significant ($p < 0.05$). These results show that increasing the length of cold treatment causes greater injury to the plants and that there is a progressive and corresponding decrease in resistance index values. Covariance analyses of the angular transformation of the percentage survival on the resistance index indicate that the relationship between survival and index is highly significant ($p < 0.001$). There is no significant residual variation between places in percentage survival when the differences in resistance index are taken into account. This suggests that the factors responsible for the differences in resistance index between locations are similar to, or identical with, the effects of exposure to cold in the experimental arrangement. The results for the crowns were fragmentary. The regression coefficient of mortality on resistance index, while not significant, was more than twice that for the stolons.

The analyses so far considered are the effects of treatment and localities on resistance indexes and mortality for populations of plants. Of greater practical interest is the possibility of predicting recovery from cold injury for plants which have been subjected to the same test conditions. For this purpose the results were regrouped, within treatments, into classes according to the resistance index. Locations were ignored because of the finding of the covariance analyses. For each class the percentage survival was calculated and a regression of transformed percentage survival on resistance index determined. A limited number of plant crowns was included in the recovery test. Twenty-five plant crowns received the 8-hr. treatments and they exhibited resistance index readings in the range 115–245; all failed to recover. Nine crowns were included in the control group, with resistance index readings in the range 382–535; all but one recovered within a few days. Within the other three treatments, there were sufficient crowns or sufficient range in recovery for statistical analyses to be carried out on only the 2-hr. treatment (with total of 17 crowns).

Table 3. REGRESSION COEFFICIENTS OF STOLONS AND CROWN ANALYSES OF *T. repens*

Treatment	Stolons	Crowns
0	7·3	—
1	4·3	—
2	8·1	21·7*
4	—	—
8	—	

* $p < 0.05$

Only the regression of mortality on resistance ratio for crowns with 2-hr. exposure to cold was significant, but the coefficients are constantly positive.

Despite the limited amount of material and the variability in its size, there is good indication that the magnitude of resistance index of a crown after cold injury gives a measure of the probability of recovery. (The resistance index method has also shown promise for determining the injury caused by drought—Greenham and Morley, unpublished.) Other experiments also suggest that it is preferable to make readings on the crowns rather than on the more variable stolons. Further investigations are planned.

We are indebted to Mr. G. A. McIntyre and Mr. M. L. Dudzinski for the statistical analyses.

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THE VITAMIN-SPARING ACTION OF SORBITOL

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IN the complete absence of dietary carbohydrate, rats are able to survive without thiamine for many months[1]. As little as 5 or 10 per cent of glucose in the diets leads to polyneuritis and death. It seems that signs of thiamine deficiency are due to the products of perverted carbohydrate metabolism[1,2], and we might look upon dietary carbohydrate as a toxic substance, the antidote to which is thiamine.

It occurred to us that these observations might allow us to determine whether a given dietary component was or was not metabolized as ordinary carbohydrate. In particular, we tried to resolve the uncertainty concerning the metabolism of sorbitol. It turned out that we were not able to do this, for our results revealed a remarkable effect of sorbitol on intestinal synthesis of B vitamins.

When we gave sorbitol to rats at levels of up to 20 per cent of the carbohydrate-free diet without thiamine, we found that they survived for 30 weeks and were still gaining weight. The same amounts of glucose led to loss of weight, polyneuritis and death in 5–10 weeks. Moreover, the animals receiving sorbitol grew much better and were in a healthier condition than those receiving the carbohydrate-free diet (Table 1).

Table 1. Effect of Sorbitol on Growth and Survival of Rats on Thiamine-free Diets

The experiment was begun with male, piebald rats, aged 47 days, four in each group. Diets contained 5 per cent mineral salts and were supplemented with all vitamins except thiamine. The carbohydrate-free diets contained casein 80 per cent, arachis oil 15 per cent; in the other diets, 5 per cent or 10 per cent glucose or sorbitol replaced the same amount of casein

Diet	Initial weight (gm.)	Survival (days)	Weight at death or at 80 days (gm.)
Carbohydrate-free	138	> 80	138
5 per cent glucose	132	57	81
5 per cent sorbitol	135	> 80	202
Carbohydrate-free	138	> 80	132
10 per cent glucose	130	48	85
10 per cent sorbitol	132	> 80	220

We now added sorbitol to thiamine-free diets containing sugar. When added to diets containing up to 40 per cent glucose, 10 per cent sorbitol gave at least as good growth as when added to carbohydrate-free diets.

These effects might have been due to thiamine as a contaminant of the sorbitol. This was unlikely, since sorbitol is made from glucose. Nevertheless, we have assayed it for thiamine by the thiochrome method and could find none.

A second possibility was that the sorbitol produces a change in the intestinal flora of the rats, so that thiamine is synthesized and is available to the host. We believe that this is what in fact occurs. The evidence is: (1) Sorbitol has a profound effect upon intestinal function. Rats put on to a diet containing 30 per cent or more of sorbitol develop severe diarrhœa and may die. With 20 per cent, a transitory diarrhœa develops, after which the amount of sorbitol may slowly be increased to 50 per cent with no further ill-effects. (2) Rats fed sorbitol for a few weeks develop greatly enlarged cæca. With 30 per cent dietary sorbitol, the weights of the cæca are three times as great as those of the control animals (Table 2). The contents are equally increased, and are much more fluid. There is less increase in the weight of the large intestine and small intestine, and no change in the weight of the stomach. (3) The tissues of rats surviving on thiamine-free diets with sorbitol contain more thiamine than those of rats moribund on thiamine-free diets with glucose. Thus, thiamine is being made available to the tissues, though not from the diet.

We are now examining the intestinal flora to see what differences are induced by sorbitol. We are also investigating other substances which, like sorbitol, may render animals independent of dietary thiamine. Finally, we are examining the possibility that nutrients other than thiamine may be produced by the administration of sorbitol.

We have so far begun an investigation to see whether sorbitol can make animals independent of dietary sources of other vitamins of the B group. Since it will take some time to investigate these singly, as we have done with thiamine, we began

Table 2. Effect of Sorbitol on Weight of Alimentary Canal. Five Animals in each Group

Organ	Wet weight (gm.)		Ratio *B*/*A*
	Diet without sorbitol *A*	Diet with sorbitol *B*	
Small intestine	3·73	5·05	1·3
Cæcum	0·43	1·29	3·0
Cæcum with contents	1·95	7·32	3·7
Large intestine	0·69	1·23	1·8
Average weight of animals	230	247	

with one or two preliminary experiments in which most or all of the B vitamins were omitted from the diet. By this means, we hoped that the condition of the animals would give us a clue as to which of the vitamins were not being provided by the action of the sorbitol on the alimentary microflora. In such an experiment, one group of animals was given 20 per cent sorbitol with only choline and inositol of the B group. That is, they were not given thiamine, riboflavine, nicotinic acid, pyridoxine, pantothenic acid, *p*-aminobenzoic acid, biotin, folic acid or vitamin B_{12}. One set of control animals was also given only choline and inositol, but with no sorbitol. As we expected, these died in 4–5 weeks from thiamine deficiency. Since we know that sorbitol renders animals independent of dietary thiamine, we gave a second set of control animals choline and inositol and thiamine, with no sorbitol. These survived for more than three months but did not gain weight and were in very poor condition. The experimental animals receiving the 20 per cent sorbitol, however, with only choline and inositol of the B group of vitamins, showed the usual initial small loss in weight but then began to gain weight and continued to do so over the same period (Fig. 1).

This surprising result led us to put some animals on a diet with sorbitol but with none of the vitamins of the B group. They have also continued to grow well for more than three months (Fig. 2).

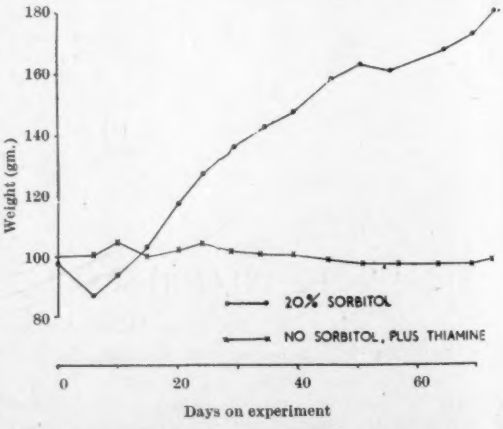

Fig. 1. Effect of sorbitol on growth of rats on vitamin B-deficient diets

Exp. 1. Four male piebald rats in each group. Both diets contained 5 per cent salts, 15 per cent arachis oil, 20 per cent casein. In addition, the control rats had 60 per cent sucrose, the experimental rats 40 per cent sucrose and 20 per cent sorbitol. Both diets also contained vitamins A, D, E and K, and choline and inositol of the vitamin B group. The control animals had thiamine in addition

We have changed over the diets of some of the animals receiving or not receiving sorbitol. The change to sorbitol resulted in a prompt increase in weight, as if the change in microflora giving the B vitamins occurred rapidly (Fig. 3). The change from a sorbitol-containing diet to one without sorbitol, but with vitamin B_1, produced no effect for a few days, and then led to a fall in weight (Figs. 3 and 4). This does not necessarily mean that the microbial change is less rapid than that occurring when the dietary change is in the opposite direction. It could be explained by the time taken for the vitamin concentration in the tissues to fall to an inadequate level.

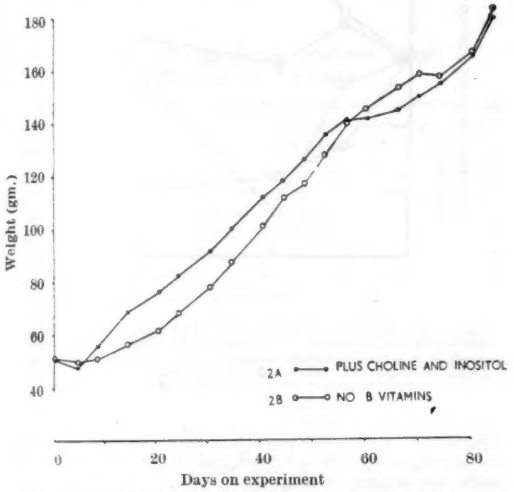

Fig. 2. Effect of sorbitol on growth of rats on vitamin B-deficient diets

Exp. 2. Three male piebald rats in each group. *A*, diet as experimental diet in Exp. 1; *B*, diet as *A*, but with no choline or inositol

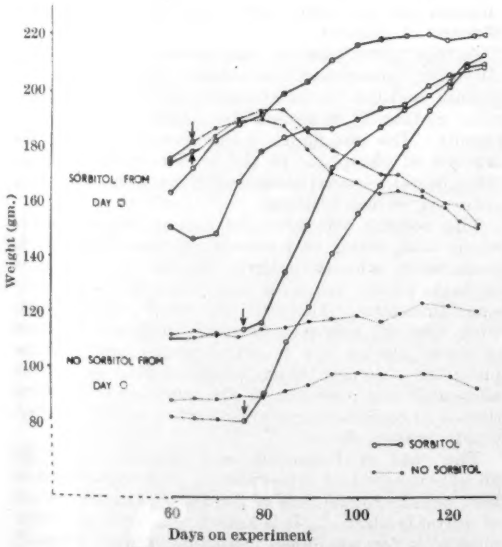

Fig. 3. Effect of change of diet

Each curve represents the growth of one animal from Exp. 1 (Fig. 1). At the indicated times, the diet of two rats in each group was changed to that of the other group. The diet of the two remaining rats in each group was unchanged

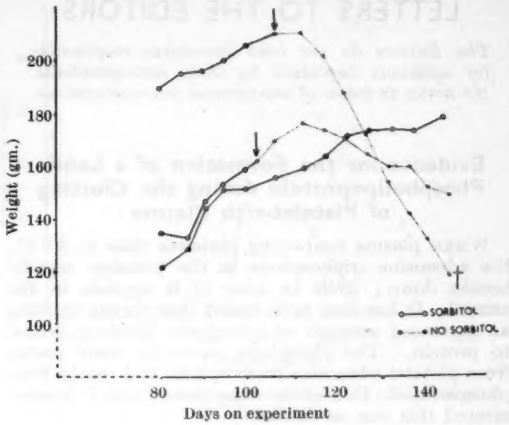

Fig. 4*A*

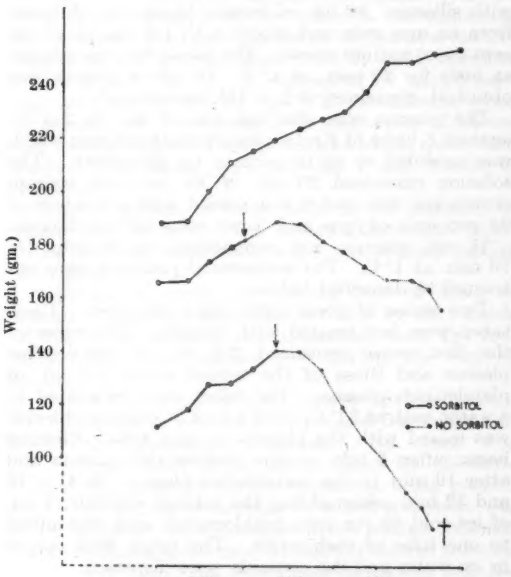

Fig. 4*B*

Fig. 4. Effect of change of diet

Each curve represents the growth of one animal from Exp. 2 (Fig. 2). At the indicated times, the sorbitol-containing diet of two of the three rats in each group was changed to the sorbitol-free diet with thiamine. *A*, diet with choline and inositol; *B*, diet with no choline or inositol

Thus, the administration of sorbitol appears to make an animal independent of dietary sources, not only of thiamine, but also of the other vitamins of the B group. We know of no similar report of a substance which can lead to intestinal synthesis of much of, if not all, the required amounts of all the vitamins of the B group. Our programme of further work includes a study of the effect of sorbitol on intestinal synthesis of vitamins in man.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Evidence for the Formation of a Labile Phospholipoprotein during the Clotting of Platelet-rich Plasma

When plasma containing platelets clots at 37° C., the adenosine triphosphate in the platelets rapidly breaks down; little or none of it appears in the serum[1]. It has now been found that during clotting an increased amount of phosphate becomes bound to protein. The phosphate seems to come partly from platelet adenosine triphosphate and partly from phospholipid. One of the experiments which demonstrated this was as follows.

All glassware with which blood or plasma came into contact before clotting was induced was treated with silicone. 80 ml. of human blood was obtained from an arm vein and mixed with 1·6 ml. of 19 per cent (w/v) sodium citrate. The blood was centrifuged at 500*g* for 20 min. at 1° C. 30 ml. of plasma was obtained, containing $4{\cdot}2 \times 10^8$ platelets/ml.

The plasma was dialysed for 24 hr. at 2–4° C. against 5 litres of Krebs's bicarbonate solution which was modified so as to contain no phosphate. The solution contained 20 ml. of 19 per cent sodium citrate per litre and it was gassed with a mixture of 95 per cent oxygen and 5 per cent carbon dioxide.

15 ml. plasma was centrifuged at 25,000*g* for 20 min. at 1° C. The sedimented platelets were extracted as described below.

Two series of glass tubes were prepared. These tubes were not treated with silicone. The tubes of the first series contained 2·5 ml. of platelet-free plasma and those of the second series 2·5 ml. of platelet-rich plasma. The tubes were incubated in a water-bath at 37° C. 0·06 ml. of *M* calcium chloride was mixed with the plasma in each tube. Clotting began after 5 min. in the platelet-rich plasma and after 10 min. in the platelet-free plasma. 0, 4, 8, 16 and 32 min. after adding the calcium chloride, 1 ml. of ice-cold 40 per cent trichloracetic acid was added to one tube of each series. The tubes were cooled in ice-water and the contents were dispersed.

The tubes were centrifuged at 3,000*g* for 10 min. at 1° C. The supernatant solutions were retained and each precipitate was extracted with 10 per cent (w/v) trichloracetic acid and then twice with water. The extracts were added to the first supernatant. The solutions were analysed for total phosphate, inorganic phosphate and organic phosphate which was hydrolysed in 10 min. in *N* hydrochloric acid at 100° C. ('10 min. phosphate'). The '10 min. phosphate' extracted from dialysed platelet-rich plasma by trichloracetic acid is almost wholly derived from adenosine triphosphate in the platelets (unpublished results). Phosphate was determined by the method of Berenblum and Chain[2].

The precipitates were dried in a vacuum over phosphorus pentoxide. They were extracted twice with a mixture containing 2 parts of chloroform and 1 part of methanol. The extracts were washed by the method of Folch[3] and the extracts and washings were analysed for total phosphate. The residues were dried and resuspended in water. Samples of each suspension were analysed for total phosphate, and for nitrogen by the micro-Kjeldahl method. The results are shown in Fig. 1.

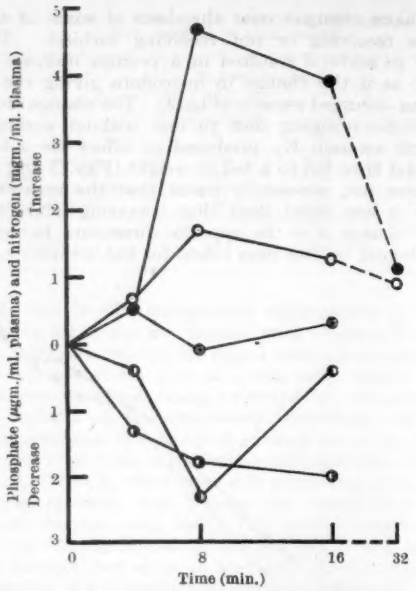

Fig. 1. Changes in the concentrations of phosphate and nitrogen during clotting of plasma. In plasma free of platelets: ⊙, Phosphate in residue. In plasma containing platelets: ●, Phosphate, and ○, nitrogen, in residue; ◑, '10-min. phosphate'; ◐, phosphate extracted by chloroform plus methanol

When the plasma clotted in the presence of platelets, the phosphate which could not be extracted from the residue increased by 4·7 μgm./ml. plasma after 8 min. and then decreased. The nitrogen in the residue increased and decreased at the same time. These changes did not occur when plasma clotted in the absence of platelets.

As the phosphate in the residue increased, the '10 min. phosphate' decreased by 1·8 μgm./ml. plasma, and the phosphate extractable by chloroform plus methanol decreased by about 2·3 μgm./ml. plasma. The last figure is less accurate because the amount of phosphate in the lipid extract was large (89 μgm./ml. plasma) compared with the changes which occurred during clotting.

The residue left after extracting with trichloracetic acid, water and chloroform plus methanol is presumably almost entirely protein since plasma contains no nucleic acids and platelets contain only small amounts[4]. Therefore the results suggest that, when platelet-rich plasma clots, increased amounts of phosphate become bound to protein, and that the phosphate comes from phospholipid, and from adenosine triphosphate in the platelets. It seems that a phospholipoprotein is formed which is afterwards broken down.

The rate of formation and destruction of the phospholipoprotein observed in this experiment is very similar to the rate of formation and destruction of 'thromboplastin'. It is known that little 'thromboplastin' is formed unless fresh platelets are present[5]. The results suggest, therefore, that plasma 'thromboplastin' is a phospholipoprotein which is formed during clotting when platelets are present. The

formation of the phospholipoprotein may involve adenosine triphosphate in the platelets.

This work will be reported more fully elsewhere.

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May 17.

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Effect of Cerebral Lesions upon Œstrus in Ferrets

Numerous clinical and experimental observations that have been reported over the past fifty years have led to the concept that the hypothalamus is the seat of specific nervous centres which subserve a variety of visceral functions. Among these are supposed to be 'sexual centres' which control: (*a*) the release of luteinizing hormone[1]; (*b*) all the gonadotrophic functions of the pituitary[2]; (*c*) ovulation[3–5]; (*d*) patterns of sexual behaviour[6,7]; (*e*) the inhibition of follicle-stimulating hormone[8,9].

The location of some of these presumed centres varies with different authors, and the same hypothalamic nuclei have been endowed by different writers with the control of completely different visceral functions (see Zuckerman[10]).

The following observations refer to the suggestion that the anterior hypothalamus of the ferret contains a centre which inhibits the production of follicle-stimulating hormone during the anœstrum. This belief is based upon the observation of Donovan and v.d. Werff t. Bosch[8,9] that bilateral lesions made during the winter in this part of the hypothalamus result in the precocious appearance of œstrus.

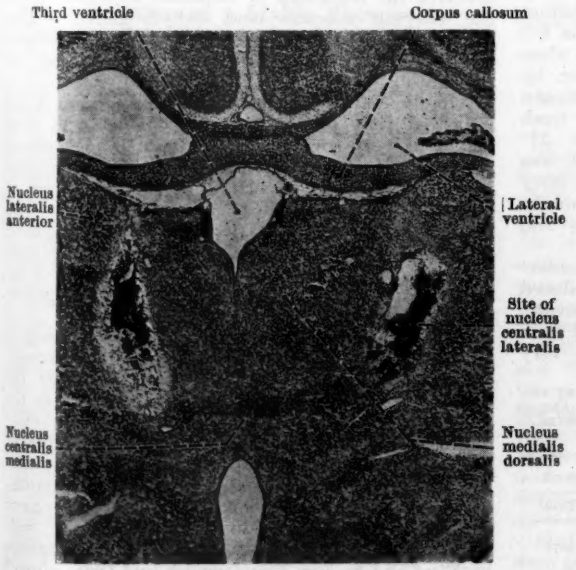

Fig. 1. Bilateral lesions in the thalamus of a ferret. × 13

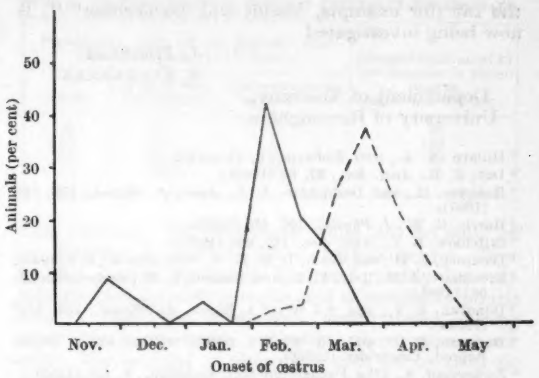

Fig. 2. Onset of œstrus in control (pecked line) and experimental (full line) animals

Bilateral electrolytic lesions were made with the help of a stereotaxic device either in the thalamus, the caudate nucleus or the fornix of fourteen mature female ferrets between September 20 and December 13, 1956 (see Fig. 1). A current of 50 m.amp./sec. was used, except in the case of three animals, when 30 m.amp./sec. were passed. A single pair of lesions was made in all cases except one, in which three were made. The lesions were between 1 and 2 mm. in diameter.

Control operations were made in ten animals, in which the electrode was inserted into the brain substance and withdrawn without a current having been passed.

Information about the normal time of onset of œstrus in intact animals was provided by the records of 145 ferrets kept in this laboratory over the preceding ten years (including 8 during the current season).

Fig. 2 shows that œstrus occurred much earlier in both sets of operated ferrets than in the unoperated animals. Its onset was accelerated in animals in which the electrode was inserted without a current being passed, as well as in animals in which a current was passed. In this respect there was no constant relation in the time of onset of œstrus between any individual ferret bearing lesions and the corresponding control-operated animal. Nor was the speed with which œstrus occurred correlated either with the date of operation or with the size, position or number of the lesions.

These results suggest that the acceleration of œstrus following operations on the brain provides no justification for assigning any specific sexual or reproductive function to any part of the brain of the ferret. In particular, they show that the fact that œstrus may be accelerated when lesions are made in the anterior hypothalamus provides no more basis for positing the existence of a sexual centre in that part of the brain than the present experiments do for the view that such a centre exists in the thalamus or caudate nucleus. The possibility that the acceleration of œstrus following intracranial operations may constitute a form of non-specific stress of the kind which leads to precocious puberty in

the rat (for example, Mandl and Zuckerman[11,12]) is now being investigated.

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Utilization of Carbohydrate Metabolites by Rumen Micro-organisms

Hershberger *et al.*[1] have recently published observations concerning the *in vitro* study of the utilization of carbohydrates and carbohydrate metabolites by rumen micro-organisms. Using a basal salt medium with an inoculum of sheep rumen liquor and a 24-hr. incubation period, these workers determined, *inter alia*, the volatile fatty acid production from pyruvic acid and lactic acid and obtained the following results (Table 1).

In somewhat similar studies in this laboratory corresponding results were obtained which are shown in Table 2. In this work the general procedures, except for the determination of volatile fatty acids, were those of Barnett and Reid[2]. The basal salts medium was that described by Burroughs *et al.*[3]; substrates were added to a concentration of 7·7 mgm./ml.; anaerobic conditions were maintained by passing carbon dioxide through the incubation mixture at 39° for 72 hr.; the initial *p*H was 6·7 and seldom fell below 6·5 but was adjusted when necessary to the initial value twice every 24 hr. by the addition of *N* sodium carbonate; the rumen liquor used in this work was obtained from fresh slaughter-house rumens and maintained at 37° during transport to the laboratory, where it was strained through muslin before use; volatile fatty acids were determined on steam distillates from the artificial rumen by the technique of James and Martin[4].

From the above information the following observations may be made: (1) Acetic acid is produced in greater amount than propionic acid from pyruvate, whereas propionic acid is the chief acid derived from lactate—in our experiments the excess was very great. (2) Pyruvic acid and lactic acid differ also with respect to butyric acid production, but in each case the total amounts of C_3–C_5 volatile fatty acids produced are similar. (3) α-Ketoglutarate gives a low total production of volatile fatty acids, mainly acetic and propionic acids.

Table 1. Production of Volatile Fatty Acids obtained by the Incubation of Pyruvic Acid and Lactic Acid, as Sole Added Carbon Substrates, for 24 hr. with a Rumen Liquor/Mineral Salt Medium (Ref. 1)

Substrate	m.moles acid/100 ml. 'rumen' contents			
	Acetic	Propionic	Butyric	Total
Salt medium + rumen liquor + pyruvate	6·76	0·90	1·08	8·74
Salt medium + rumen liquor + lactate	4·15	4·51	0·32	8·98

Table 2. Production of Volatile Fatty Acids obtained by the Incubation of Pyruvate, Lactate and α-Ketoglutarate as Sole Added Carbon Substrate, for 72 hr. with a Rumen Liquor/Mineral Salt Medium at *p*H 6·7 and 39° in an Atmosphere of Carbon Dioxide

Substrate	Proportional distribution of volatile fatty acids (per cent)						Total volatile fatty acids (mgm./100 ml. 'rumen' fluid)
	C_2	C_3	*iso*-C_4	*n*-C_4	*iso*-C_5	*n*-C_5	
Salt medium + rumen liquor + pyruvate	80·0	5·8	0	9·5	2·6	2·1	300
Salt medium + rumen liquor + lactate	20·3	51·8	0·8	21·1	1·6	4·4	280
Salt medium + rumen liquor + α-ketoglutarate	61·5	30·2	0	4·3	0	4·0	60

To explain the above observations, it may be recalled that in Propionibacteria it has been suggested that propionic acid is formed from succinic acid by decarboxylation[5]. There is evidence[6] that succinic acid may be produced from intermediates such as lactic acid or pyruvic acid in either of two ways: (*a*) by conversion of pyruvic into oxaloacetic acid and thence through malate and fumarate into succinate; (*b*) by condensation of acetate (derived from pyruvate) with oxaloacetate to yield citrate and hence through the steps of the tricarboxylic acid cycle to give succinate. A modification of the latter process might involve the recently described glyoxylic acid cycle (Kornberg and Krebs[7]), according to which the citrate will yield succinate and glyoxylic acid; the latter, by condensation with acetate, will yield malate and thence oxaloacetate to continue the cycle.

The characteristic feature of route (*a*) is that it involves the reduction of fumarate to succinate by the enzyme succinic acid dehydrogenase. This enzyme catalyses the interconversion of succinate and fumarate reversibly and is inhibited by malonate[8].

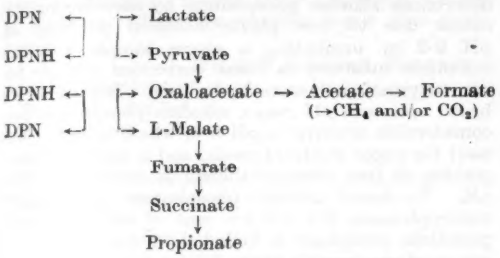
A preliminary experiment in the present work has indicated that production of propionic acid from lactate is very substantially reduced if malonate is present, and so it would appear that in our experiments route (*a*) is important in the production of propionic acid, a result in general agreement with those of Hershberger *et al.* (*loc. cit.*). This observation is supported by the fact that α-ketoglutarate gives little propionate, although the interpretation of the results is complicated by the possible low permeability of the cells to α-ketoglutarate.

It is to be observed that when lactate is used as substrate in these experiments as opposed to pyruvate, the conversion of lactate to pyruvate under the influence of lactic acid dehydrogenase involves the formation of reduced diphosphopyridine nucleotide and a supply of this is required for the reduction of oxaloacetate to malate and (indirectly) for the reduction of fumarate to succinate. Thus it is not surprising that in the anaerobic conditions of the experiment the ratio of propionate to acetate is greater with lactate than with pyruvate. It has been suggested by Fitz[9] and by von Freudenreich and Orla Jensen[10] that lactic acid (3 moles) may undergo dissimilation

to propionic acid (2 moles) and acetic acid (1 mole). In the absence of a detailed mechanism, this reaction may be regarded as a summary of the overall process postulated here.

The acetate formed under the anaerobic conditions of our experiments is likely to be produced from pyruvate by hydrolytic fission into acetate and formate rather than by the oxidative decarboxylation characteristic of aerobic tissues.

These ideas are summarized in the following scheme:



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Accumulation of a Stable Phosphorus Compound in Glycolysing Insect Muscle

IN isolated metathoraxes of the cockroach *Periplaneta americana*, 85 per cent of the mass of which is formed by the thoracic muscles, changes in various fractions of acid-soluble phosphorus compounds were followed during exposure of the preparations to anoxia. It was found that in such conditions there is a rapid breakdown of the labile phosphorus compounds, namely, arginine phosphate and adenosine triphosphate[1]. At the same time, however, the level of inorganic phosphate did not increase significantly; on the contrary, in many cases it showed a tendency to decrease. As the total acid-soluble phosphorus did not change at all, these facts indicated an accumulation of some stable phosphorus compound during anaerobiosis: this compound was found to be stable even to prolonged acid hydrolysis (three hours in normal acid).

To obtain some information about the nature of this compound, the trichloracetic acid extract of the muscles was subjected to fractionation by means of the salts of alkaline earth metals[2]. For this purpose six hemi-metathoraxes weighing about 0·6 gm. were combined, the symmetrical halves serving as control. The stable ester formed in anaerobiosis was found quantitatively in the barium soluble – alcohol insoluble fraction. Its phosphate could not be split off by heating in normal alkali hydroxide for three hours; it was, however, liberated readily by subsequent heating with periodic acid in normal sulphuric acid. Thus the compound accumulated during anaerobiosis is most probably glycerophosphoric acid. The amount of phosphate split off by periodic acid treatment and the calculated amount of glycerophosphate, expressed as glycerol, are given in Table 1.

Table 1. STABLE PHOSPHATE ESTER IN COCKROACH METATHORAXE

Phosphorus split off by periodic acid treatment (mgm. per 100 gm.)			Glycerol equivalent to the increase in phosphorus (mgm. per 100 gm.)
Aerobic	After 40 min. anaerobiosis	Increase during anaerobiosis	
5	36	31	92
13	55	42	124
20	52	32	95
9	32·5	23·5	70

The formation of glycerophosphate in insect muscle during glycolysis is quite possible, as the activity of α-glycerophosphate dehydrogenase was found to be very high in this tissue[3]. In parallel experiments, during the same period of anaerobiosis, glycogen breakdown was found to be equivalent to 250 ± 33 mgm. per cent glucose in these preparations; thus glycerophosphate would constitute a considerable proportion of the breakdown products, which would explain low yields of lactic acid in glycolysing insect muscle[4]. As glycerophosphate would be most probably formed by triosephosphate dismutation, the occurrence of pyruvate among the products of insect glycolysis[5] would also be explained.

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Isolation of 2-Aminoethanesulphinic Acid from a Mollusc

PAPER chromatographic analyses of extracts from *Septifer* (*Mytilisepta*) *virgatus* (Wiegmann) by means of the iodine–azide reaction[1] showed the presence of an unusual sulphur compound, leading to its isolation. The isolate was identified as 2-aminoethanesulphinic acid. In 1951 Bergeret and Chatagner[2] observed paper chromatographically that this compound was formed from cysteinesulphinic acid by the action of liver acetone powder. Furthermore, in 1953, Awapara and Wingo[3] isolated ^{35}S-2-aminoethanesulphinic acid and ^{35}S-taurine from rat liver after injection of ^{35}S-cysteine. 2-Aminoethanesulphinic acid, however, has never been reported to be isolated directly from organisms under natural conditions without administration of the precursors such as cysteinesulphinic acid, cysteine or cystine. We have found that every tissue of this *Septifer* contains this compound in considerable quantity.

Shells of the *Septifer* were removed and the contents were ground in a mixer with water. The extract was deproteinized with ethanol, centrifuged, the precip-

itate separated from the supernatant liquid was washed with water, and the washings after deproteinization and centrifugation were mixed with the supernatant liquid obtained above. The mixed solution was passed through a column of 'Amberlite *IR*-120' in the acid form. After washing the column with water, the fraction containing the sulphinic acid was eluted with about 1 *N* ammonia. The elute was evaporated up to dryness under reduced pressure in an inert gas. The residue was then dissolved in a small amount of water. After removal of the insoluble part, the solution was passed through a column of 'Amberlite *IRC*-50' previously treated with hydrochloric acid. The resultant solution was again passed through a column of 'Amberlite *IR*-4*B*' previously treated with a sodium hydroxide solution. The latter two operations were repeated two to three times. By these procedures a considerable amount of impurity was removed. The fairly pure sulphinic acid fraction obtained thus was treated once more with about ten times as much as necessary of the acid form of 'Amberlite *IR*-120' to adsorb the required compound completely; the latter was found only in the first effluent portion by elution with about 0·01 *N* hydrochloric acid. When this portion was concentrated under reduced pressure and then allowed to stand out of contact with air in an ice-box with the addition of ethanol, colourless crystals of the sulphinic acid appeared. Approximately 30 mgm. was obtained from 1 kgm. of fresh material without shells (paper chromatographic analysis indicated that the organism contains about 150 mgm. per kgm.).

The basis of identification of the isolate was as follows. It gave taurine easily and quantitatively by oxidation with hydrogen peroxide and showed the same paper chromatographic behaviour as the synthetic 2-aminoethanesulphinic acid according to Awapara's method[4]. The R_F values between the isolated and the synthetic compounds in tertiary butanol / formic acid / water (75 : 15 : 10), normal butanol/acetic acid/water (4 : 1 : 1) and luthidine/water (75 : 25) agreed satisfactorily with each other and were 0·34, 0·21 and 0·19, respectively; these are different from those for taurine and cysteine. The elementary analysis of the isolate was C, 21·86; H, 6·48; N, 12·38; S, 29·84 per cent; the calculated values are C, 22·02; H, 6·42; N, 12·84; S, 29·36 per cent. This sulphinic acid gave the iodine–azide reaction, though it was not very sensitive, while the reaction was insensitive to taurine and sensitive to cysteine. On the other hand, cysteine reacted with alkaline sodium nitroprusside, whereas the other two did not.

It is very interesting that an easily oxidizable compound such as 2-aminoethanesulphinic acid should exist in this mollusc in relatively high content; it explains the cysteine metabolism of the organism.

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Location of Alpha-2-Globulin by Demonstration of Alkaline Phosphatase during Paper Electrophoresis

On electropapergrams, the alpha-2-globulin protein peak has been shown to coincide exactly with the locus of maximum non-specific alkaline phosphatase activity[1]. This enzyme may be detected during the run by an adaptation of the Huggins and Talalay sodium phenolphthalein phosphate method, which determines alkaline phosphatase by ascertaining the colour due to free phenolphthalein produced at *p*H 9·2 by incubating a serum sample with the colourless substrate (a blank correction is made for non-enzymatic substrate hydrolysis). Because of its broad optimum *p*H range, alkaline phosphatase has considerable activity at *p*H 8·6, which is most often used for paper electrophoresis, and a significant proportion of free phenolphthalein is coloured at this *p*H. To detect alkaline phosphatase during paper electrophoresis, 0·1–1·0 per cent of sodium phenolphthalein phosphate is included in the buffer; the region of enzymatic activity is seen as a well-localized red band. At *p*H 9·2 the band is considerably more impressive in colour.

The colour of the band reaches a maximum early in the run, which presumably means that, as free phenolphthalein is produced at the enzyme site, its ionic binding to the enzyme is disrupted by the current. Therefore, for maximum sensitivity and quantitative measurement, the strip is incubated after the run for 1 hr. at 37° C. in a moist atmosphere and then air-dried at room temperature. The phenolphthalein colour fades during drying (in our highly acid city air) but may be restored by spraying lightly with saturated trisodium phosphate. Because results with the original sodium phenolphthalein phosphate method were not linearly comparable to those of more popular techniques (Cohn, C., and Wolfson, W. Q., unpublished work), this seems likely to be

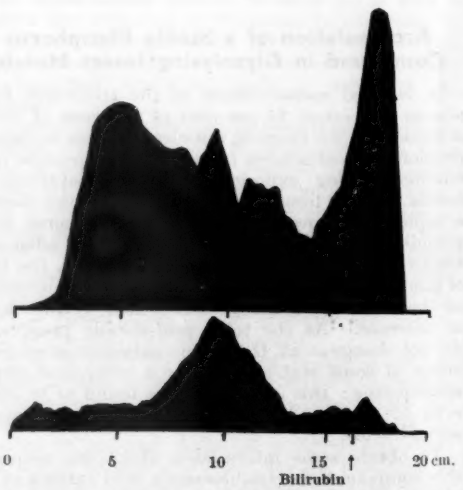

Fig. 1. Transmittance scanning curves of an electropapergram of pooled icteric serum from patients with obstructive jaundice due to intrahepatic obstruction. The sample was dried and sprayed as described in the text to give the lower curve of free phenolphthalein. For fixation it was then heated to 95° C. for a few minutes, washed with tap water to remove trisodium phosphate, and stained with amidoschwarz to determine the protein distribution and scanned to give the upper curve

true of its electropapergram modification. On the other hand, sera with elevated enzyme-levels give bands obviously more intense than do normal sera. The only critical step in the method is spraying; free phenolphthalein is very diffusible, and care must be taken not to over-spray. If the colour fades after the first spraying, one should wait until the sheet is again dry and then repeat.

I wish to thank Dr. Irving I. Young of the Department of Medicine, Wayne State University College of Medicine, whose co-operation made this study possible.

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Survival of Human Circulatory Leucocytes *in vitro*: Life-span and Nucleic Acid Turnover

IT is obviously advantageous to investigate the metabolism of mammalian cells maintained as a suspension *in vitro* without previous damage to them by mechanical or enzymatic treatment. Circulatory leucocytes are eminently suitable for such a study, the more so because of their role in defence mechanisms. Most of the work done on leucocytes has been concerned with their morphology, the cells being usually derived from bone marrow and from pathological cases; and cultivation has been carried out using some solid or semi-solid supporting medium. We have been able to maintain normal circulatory leucocytes *in vitro* as a suspension for three to four days using a medium similar to that employed by Osgood *et al.*[1].

Normal blood donors were bled into a bottle containing a solution of acid-hydrolysed gelatin (intrinsic viscosity 0·13 dl./gm.) and heparin. Nine volumes of blood were taken into one volume of solution, bringing the final concentration of gelatin to 1 per cent and that of heparin to 2 units per ml. The sedimentation of erythrocytes was allowed to proceed for about an hour, plasma with white blood cells separated and spun at 220*g*. The sediment containing all the white cells with a few remaining erythrocytes (2–5 per white blood cell) was diluted with culture medium to 15,000 cells per μl. The culture medium was composed of Hanks-Simms' balanced salt solution fortified with 35 vol. per cent of pooled human serum, previously heated for ½ hr. at 56° C., glucose (100–300 mgm./100 ml.), sodium acetate (200 mgm./100 ml.), ascorbic acid (1·5 mgm./100 ml.) and penicillin (50 units per ml.). Heparin (0·5 unit per ml.) was also incorporated into this medium: heparin appears to be essential in order to prevent the cells from clumping together during subsequent incubation.

The suspension of cells was then pipetted into 100-ml. conical flasks, previously filled with 7 ml. of culture medium; each flask finally contained, in various experiments, from 3,000 to 5,000 cells per μl. All the manipulations were carried out at 0° C. under sterile conditions.

Within the first hour of incubation, some of the cells stuck to the bottom of the flask and then slipped back into the solution, forming an even, opalescent suspension. The morphological appearance and amœboid movements were normal, as seen in the phase-contrast microscope. The flasks were incubated at 37° C. without shaking.

Table 1. GLUCOSE CONSUMPTION AND CELLULAR ESTER PHOSPHATES DURING INCUBATION OF LEUCOCYTES

Hours	Glucose in medium (mgm./100 ml.)			Ester-phosphorus in cells (μgm. phosphorus per flask)		
	1	2	3	4	5	6
0	117·3	109·9	305·5	15·1	21·4	14·8
24	99·1	69·0	270·4	7·5	13·8	9·0
48	81·6	45·7	243·6	4·2	8·2	7·6
72	71·0	35·0	238·0	2·4	6·4	4·8
96	65·8	—*	—	2·2	3·9	2·8

Each column refers to a separate experiment.
* Not done.

Life-span. The nuclear count was maintained throughout incubation without marked change; this, of course, is no measure of the survival of the cells. Their morphological appearance slowly deteriorated, the number of naked nuclei and lymphocyte-like structures increasing at the expense of neutrophils.

The number of cells capable of phagocytosis, glucose consumption and the quantity of intracellular phosphate esters were determined as an index of biological activity, metabolic capacity and integrity of cytoplasm, respectively. Some of the results are shown in Table 1. The results for eight experiments are given for each consecutive day, as a percentage of the corresponding value at the start of the experiment in Fig. 1.

It is evident that the time course of the regression of all three indexes follows a similar trend, from which the half-life of a leucocyte can be estimated as 36 hr.; the average life-span under these conditions *in vitro* is therefore 25 hr. This figure agrees well with the figure of 48 hr. calculated by Osgood *et al.*[1] for segmented neutrophils from human marrow.

Phosphorus turnover. For the determination of phosphorus turnover, $Na_2H^{32}PO_4$ was added to the flasks, bringing the final activity of the medium to $0{\cdot}5–1{\cdot}0 \times 10^6$ counts per min. per ml. Previous to fractionation, the cells were spun down, washed once with 1 per cent acetic acid in order to remove remaining erythrocytes and denatured with 10 per cent trichloracetic acid. The fractionation was carried

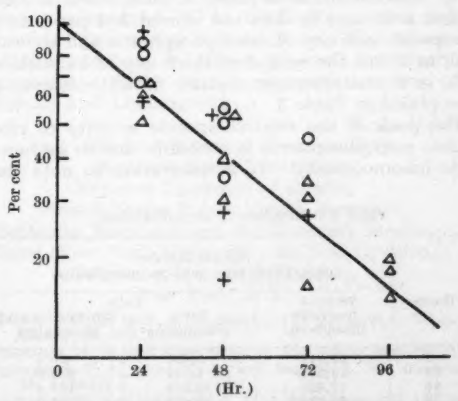

Fig. 1. Decay of leucocytes. —○—○—, Phagocytosis; —×—×—, glucose consumption; —△—△—, ester phosphates. The graph has been constructed using the method of least squares

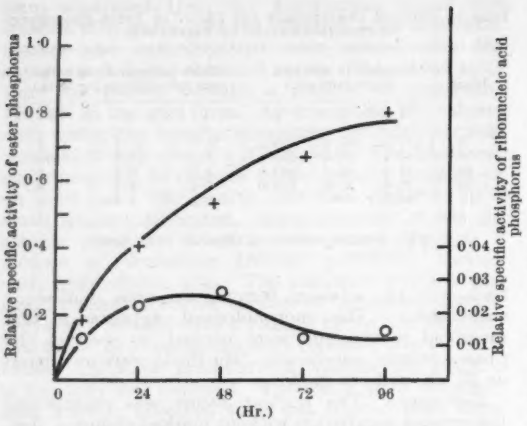

Fig. 2. Phosphorus turnover. —+—+—, Relative specific activity of ester phosphorus; —○—○—, relative specific activity of ribonucleic acid phosphorus

out by the method of Schmidt and Tannhauser as modified by Davidson and Smellie[2]. The ester-phosphate fraction was freed of inorganic phosphate by the method of Rose and Ochoa[3]. Phosphorus was determined by the method of Berenblum and Chain[4]. The butanol extracts were dried on plastic planchettes and counted using an end-window Geiger–Müller counter and a conventional scaler; the standard deviation of counting was kept at or below 1 per cent.

Table 2 shows the results obtained in a typical experiment. It can be seen that phosphorus is being actively incorporated into both ester phosphates and ribonucleic acid. No incorporation in the deoxyribosenucleic acid was found.

Relative specific activity of ester phosphorus was calculated from the ratio of its specific activity to the specific activity of inorganic phosphate in the medium; the relative specific activity of ribonucleic acid phosphorus was calculated from the ratio of its specific activity to the specific activity of ester phosphorus. The results are shown in Fig. 2.

It can be seen that the turnover of ester phosphates is relatively slow: equilibrium with the medium is approached only after three to four days of incubation. The maximum activity of phosphorus in ribonucleic acid usually does not exceed 3–4 per cent of the specific activity of ester phosphorus and shows a peak at about the second or third day of incubation. This is a characteristic feature of all cultures, as exemplified in Table 3.

The peak of the relative specific activity of ribonucleic acid phosphorus is probably due to its metabolic inhomogeneity. It is interesting to note that

Table 2. Phosphorus Incorporation

Hours	Specific activity (counts per min. per μgm. phosphorus)		
	Medium: Inorganic phosphorus	Cells: Ester phosphorus	Cells: Ribonucleic acid phosphorus
8	19,542	1,626	19·8
24	19,399	4,642	215·6
48	17,658	10,118	167·4
72	15,335	12,815	268·5
96	14,475	16,066	—

Table 3. Ribonucleic Acid Turnover

Hours	Relative specific activity of ribonucleic acid phosphorus	
	1	2
8	0·015	0·012
24	0·030	0·046
48	0·023	0·017
72	0·022	0·021

the relative specific activity of ribonucleic acid phosphorus begins to decrease at about the same time as the capacity for phagocytosis drops to a very low value.

Summarizing, this investigation shows that normal circulatory leucocytes can survive for a few days *in vitro* as a suspension; that is, in a similar state to that in which they occur *in vivo*. This opens up new possibilities for the investigation of the biochemical mechanisms underlying their role in the defence of the body.

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A Difference in the Physiology of the Large Intestine between European and Indigenous Cattle in the Tropics

A question of some importance in the tropics is the reason for the superior ability of the indigenous, humped cattle, *Bos indicus* (zebus), to thrive on dry, coarse pasture compared with the European-type cattle, *Bos taurus* (grades). The differences between the two types in this respect have not been well defined or the causes intensively sought. Since the rumen microflora is readily adaptable to a particular diet, it is unlikely that the difference lies in the digestion of fibre in the rumen. Digestibility trials with the two types of animals have indicated that this may be correct and have suggested that a difference may exist in the simple gut.

It had already been found that there was a difference between the fæces of the two animals when E. Brauwer and E. J. v. Weerden[1] published their investigations on the osmotic pressure of the gut contents of grades.

We then determined freezing-point depressions and dry matters of the contents of the abomasum, three parts of the small intestine, the cæcum and three parts of the large intestine in both types of cattle. The means of the freezing-point depressions and dry matters, the differences of means and the significance of the differences are given in Table 1. These gut samples were taken within two hours of death from twenty animals of each type selected at random in a slaughter-house.

The fæces samples were taken from cattle in the field. The actual osmotic pressures and dry matters were found to vary with time and place; but when samples were collected from groups of each type

Table 1. FREEZING POINT DEPRESSIONS AND DRY MATTER PERCENTAGE OF THE GUT CONTENTS OF *B. indicus* AND *B. taurus*

	Freezing point depression				Dry matter			
	Means		Difference of means	Significance of difference	Means		Difference of means	Significance of difference
	B. indicus	*B. taurus*			*B. indicus*	*B. taurus*		
Abomasum	0·549	0·555	0·006	nil	—	—	—	—
Duodenum	0·912	0·874	0·038	nil	13·8	9·8	4·0	nil
Jejunum	0·917	0·969	0·052	nil	10·0	11·0	1·0	nil
Ileum	0·654	0·668	0·014	nil	8·1	8·8	0·7	nil
Cæcum	0·566	0·526	0·040	nil	15·0	12·8	2·2	5 per cent
Proximal colon	0·583	0·545	0·038	5 per cent	13·8	12·3	1·5	5 per cent
Middle colon	0·511	0·463	0·048	app. 5 per cent	14·0	12·2	1·8	1 per cent
Distal colon	0·483	0·373	0·110	1 per cent	15·8	14·5	1·3	nil
Fæces, group 1	0·510	0·287	0·223	0·1 per cent	14·1	10·9	3·2	1 per cent
Fæces, group 2	0·358	0·287	0·071	5 per cent	16·1	14·1	2·0	5 per cent
Fæces, group 3	0·369	0·231	0·138	0·1 per cent	—	—	—	—
Blood	0·541	0·531	0·010	nil	—	—	—	—

grazing together or near each other at the same time, there was always a significant difference between means. The means of three groups of fæcal samples are given in Table 1. Group 1 consisted of samples from six steers of each type which had been grazing together for several months. Group 2 was a repetition with this herd a few months later, and the blood samples were also taken from this herd. Group 3 was made up of ten fæces samples from a herd of each type grazing near each other at the same time on similar pasture.

Differences in freezing points and dry matter occur in the large intestinal contents and fæces, the osmotic pressures and dry matter of both being greater in zebus than grades. The results differ significantly from those of Brauwer and v. Weerden in that the fæces osmotic pressure of European cattle is lower here than the value they give. This may be due to climatic causes; but we have evidence (unpublished) that a difference between sexes exists in the properties of the fæces and may be relevant here since we obtained all our fæces samples from steers. The higher dry-matter content of the gut contents of zebus over grades may be connected through water economy with the greater tolerance of this type to hot and dry conditions.

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Missing Step in Man, Monkey and Guinea Pig required for the Biosynthesis of L-Ascorbic Acid

MAN, other primates and guinea pig are the only mammals that are known to be unable to synthesize L-ascorbic acid; thus they require vitamin C in their diet to prevent scurvy. The rat, a typical species that is independent of a dietary source of the vitamin, synthesizes L-ascorbic acid from D-glucose as follows[1-4]: D-glucose → D-glucuronolactone → L-gulonolactone → L-ascorbic acid. Recent studies[4-6] show that guinea pigs are unable to convert L-gulonolactone to L-ascorbic acid, a step which is catalysed in rats by enzymes present in liver. This communication reports that man and monkey also cannot convert L-gulonolactone to L-ascorbic acid.

L-Gulonolactone-1-^{14}C was incubated in homogenates of human and monkey liver and the amount of carbon-14 incorporated into L-ascorbic acid was measured by a procedure used previously[6].

Table 1. CONVERSION OF L-GULONOLACTONE-1-^{14}C TO L-ASCORBIC ACID IN HUMAN, MONKEY, GUINEA PIG AND RAT LIVER HOMOGENATE*

Species	No. of experiments	Average conversion (per cent)
Rat	4	8·0 ± 1·9†
Man‡	3	< 0·07
Monkey	2	< 0·07
Guinea pig	3	< 0·05

* Experimental conditions and procedure for isolation of L-ascorbic acid were same as those used previously (ref. 6).
† Average deviation.
‡ Samples of human liver were obtained by surgical biopsy.

In Table 1 the results of these experiments are compared with those obtained previously for rats and guinea pigs[6]. Appreciable incorporation of carbon-14 into L-ascorbic acid was observed in rat liver but none was detected in human, monkey and guinea pig liver; values being less than one one-hundredth those obtained in rats. Finding that man, monkey and guinea pig are unable to convert L-gulonolactone to L-ascorbic acid points out the biochemical step missing in the liver of these species required for the biosynthesis of L-ascorbic acid. (Unpublished observations show conversion of D-glucuronolactone-6-^{14}C to labelled L-gulonic acid in monkey, guinea pig and rat liver. The occurrence of this reaction in guinea pig and rat liver was suggested initially from enzymatic studies of ul Hassan and Lehninger[4].)

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The Sex-linked Difference in Rabbit Neutrophils

In most of the laboratory animals, including the mouse, rat, hamster, guinea pig and rabbit, the sex chromatin discovered by Barr and his co-workers cannot clearly be demonstrated in the tissue cell nuclei[1]. Lüers, however, reported a sex difference in rabbit neutrophil polymorphonuclear leucocytes, comparable to the one Davidson and Smith had already described in the human, where the female sex is characterized by the presence of a 'drumstick' appendage of the nucleus in a small and variable percentage of the neutrophils[2,3].

We are able to confirm this finding. However, in view of the heavily staining, granular cytoplasm of rabbit neutrophils, we abandoned the Pappenheim stain used by Lüers for a simpler colouring method with Harris's alum hæmatoxylin, acidified or not with glacial acetic acid (1 per cent) and diluted with distilled water (50 per cent). It is an essential part of the Papanicolaou staining method, which gave us very good results in the cytological and sex chromatin study of vaginal and urethral smears[4]. The stain is commercially available or may be prepared according to the well-known formula[5]. The blood films should be made thin and even, and allowed to dry at the air. They are put in the hæmatoxylin for two to three minutes, rinsed three times in distilled or tap water, blotted with filter paper and dried. They may be studied at once, using the immersion objective.

The red blood cells and the leucocyte cytoplasm are but faintly coloured, while the nuclear chromatin structures stand out sharply, occasionally allowing the observation of some hitherto undescribed details of the peculiar drumstick appendage. In many instances, the centre of the drumstick head appears lighter than its circumference to the point of resembling a hole. Some pattern may be interpreted as a transition towards a still more occasional morphological peculiarity, consisting in the more or less pronounced splitting up of the drumstick in two juxtaposed oblong chromatin formations (Fig. 1,*e*).

After preliminary trials a total of seventy-four blood smears, numbered in random order and registered by an assistant, were obtained from fifteen male and twenty-one female rabbits of five different breeds.

In the blood smears of female rabbits, the typical drumstick was found in an unexpectedly high proportion of the neutrophil leucocytes. We made a distinction between 'certain' drumsticks, lying completely free from other nuclear structures, and therefore well outlined and entirely typical, and 'probable' drumsticks, which were still recognizable, but not entirely outlined, being sessile or slightly superposed on the rest of the nucleus. Every other strongly suggestive structure in this sense was called 'possible' drumstick. By studying no more than twenty neutrophils in each smear, it was possible to determine exactly in all instances the sex of the unknown donor animal. Only in one male rabbit was a 'probable' drumstick found and the count continued to thirty neutrophils for the sake of safety. In no single instance was a 'certain' drumstick found in the blood smear of the male animal. The numerical results of this study are summarized in Table 1.

Table 1

Sex of rabbits	Female	Male
Number of blood smears	41	33
Total of neutrophils studied	820	670
Number of 'certain' drumsticks	156 (19 per cent)	0
Number of 'probable' drumsticks	66 (8 per cent)	1 (0·15 per cent)
Number of 'possible' drumsticks'	68 (8 per cent)	19 (3 per cent)

The frequency of drumsticks in the female rabbit blood smears, studied with our technique, approaches 20 per cent, the highest mean value hitherto described in any species. In fact, with some experience and accepting that no typical drumstick ever occurs in the male rabbit blood smear, counting—a cumbersome drawback of similar studies in the human—is no longer essential.

The remarkable work of Jost on the role of the fœtal testis in genital development[6] was convincingly supported by the discovery of the sex chromatin and its study in cases of human sexual malformation[7]. Most of this work was performed on rabbits—in this respect very suitable experimental animals. Simple and accurate determination of their blood sex type opens still further research possibilities. It was advanced by Briggs and Kupperman that endocrine factors have a bearing on the incidence of the drumstick in the human female[8]. Von Harnack and Strietzel directed attention to the higher incidence in premature and newborn babies of female sex[9]. The rabbit might be an animal of choice in the experimental investigation of this problem.

It has been generally assumed that the sex chromatin body is derived from (heteropycnotic portions of) the chromosome complex, *XX*, and that the drumsticks are constituted by sex chromatin. For these assumptions direct proof is still lacking, but a lot of indirect evidence has been assembled, some of which seems to be confirmed by our observations. The splitting-up phenomenon in drumsticks immediately reminded us of the studies of Crouch and Barr on female cat's neurons during axon reaction[10]. They occasionally observed a bipartite sex chromatin body, appearing "similar to a diplo-

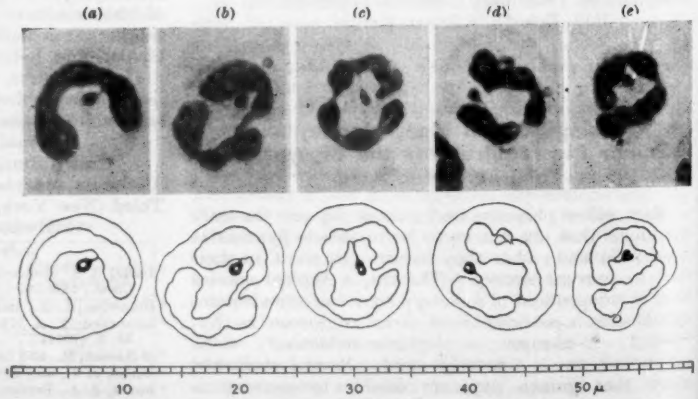

Fig. 1

coccus" and presumably derived from the two *X*-chromosomes. In another study, Moore and Barr gave a similar explanation of the minute pale area observed within the sex chromatin corpuscle[11]. Of course, completely analogous views may be held as to the structural details of rabbit drumsticks, reported above. Ranging from those with a central hole to those with a frankly split-up aspect, a continuous series of drumsticks with increasingly bifid character can be constituted (Fig. 1,*a–e*). A bipartite composition of the drumstick and an intimate relationship to the *XX*-chromosome-complex and to (intranuclear) sex chromatin is therefore strongly suggested. The drumstick may thus tentatively be considered as a sex chromatin body, characteristically bulging out of the nucleus in some of the neutrophil leucocytes.

Preliminary observations indicate that with the staining method indicated above, similar details may also be observed in human drumsticks.

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Effects of Molybdenum and Copper on some Enzymes in *Neurospora*

It is well established that copper and molybdenum are reciprocally antagonistic in animal metabolism; but the causal mechanism is not known[1]. Zinc toxicity in the rat has been shown to deplete liver catalase and cytochrome oxidase, which were restored to normal levels by incorporating small amounts of copper sulphate in the diet[2].

In a factorial experiment we have determined the effects of copper and molybdenum at deficient, optimal and toxic levels (based on dry-weight yields of the felts) in the basal medium on a range of enzymes in *Neurospora*. The results show that the effect of molybdenum at toxic levels in depressing some enzymes can be alleviated by increasing copper and vice versa. Other enzymes reduced by toxic levels of copper or molybdenum were either not restored or were depressed further

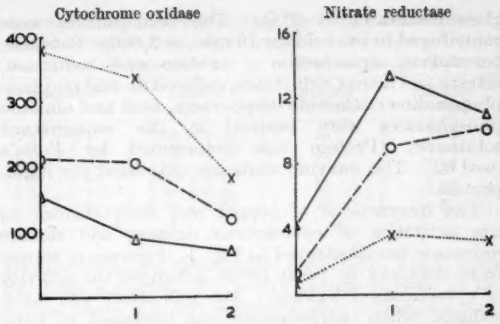

Fig. 1. The effects of copper and molybdenum on cytochrome oxidase and nitrate reductase. Abscissæ: cytochrome oxidase, change in log I_0/I_1 of 0·001/min./mgm. protein or nitrate reductase, mμM NO_3/10 min./mgm. protein; Ordinate: molybdenum treatments. △, Cu_0; ○, Cu_1; ×, Cu_2. (Copper and molybdenum treatments as in Table 1)

by increasing the other metal in the medium. Thus cytochrome *c* oxidase and its reductase, depressed by molybdenum excess, were partially reconstituted by increasing copper whereas the reverse relationship was found for nitrate reductase. Acid phosphatase, reduced by molybdenum toxicity, was not corrected by copper treatment. The diaphorase of reduced triphosphopyridine nucleotide was decreased by high copper levels irrespective of the molybdenum status. Nitrite reductase was depressed either by molybdenum or copper at toxic levels whereas catalase, reduced diphosphopyridine nucleotide diaphorase and alkaline phosphatase were unaffected at any level or combination of the two metals employed in the experiments.

Neurospora crassa macroconidial wild type 5297*a* was grown in a modified Fries medium with sodium nitrate as the sole source of nitrogen[3], and molybdenum and copper were removed from the basal culture solution by methods described previously[4]. Molybdenum (sodium molybdate) was supplied at 0–0·004, or 40 mgm., and copper (copper sulphate) at 0–0·016 or 2 mgm. in 200 ml. culture solution contained in 1-litre Erlenmeyer flasks. The three replicates for each treatment were randomized in the incubator, and after four days growth in the dark at 30° C. the felts from the same treatment, collected in a Büchner funnel, were well washed with glass-distilled water and put in a deep-freeze unit at − 17° C. for 12 hr. The felts were then ground with four times their weight of 0·1 *M* phosphate buffer (*p*H 7·5) in a cold mortar and then in a Ten Broeck

Table 1. Effects of Copper and Molybdenum Treatments on Reduced Triphosphopyridine Nucleotide Diaphorase and Acid Phosphatase (Enzyme Units, see Ref. 3)

Enzyme	Reduced triphosphopyridine nucleotide diaphorase			Acid phosphatase		
Treatments	Mo_0	Mo_1	Mo_2	Mo_0	Mo_1	Mo_2
Cu_0	107	579	355	1·74	1·40	0·82
Cu_1	415	463	175	1·62	1·00	0·94
Cu_2	81	47	20	1·62	1·21	1·02

Significant difference for copper means: 111·4 (5 per cent); 168·8 (1 per cent); 271·3 (0·1 per cent).
Significant difference for molybdenum means: 0·350 (5 per cent); 0·531 (1 per cent); 0·853 (0·1 per cent).

mgm./200 ml. culture solution			
Mo_0	0	Cu_0	0
Mo_1	0·004	Cu_1	0·016
Mo_2	40·0	Cu_2	2·6

glass macerater at 0° C. The homogenates were centrifuged in the cold for 10 min. at 3,000*g*. Catalase, peroxidase, cytochrome *c* oxidase and reductase, nitrate and nitrite reductases, reduced di- and tri-phosphopyridine nucleotide diaphorases, acid and alkaline phosphatases were assayed in the supernatant solutions[3]. Protein was determined by Folin's method. The enzyme units are expressed per mgm. protein.

The interactions of copper and molybdenum on the activities of cytochrome oxidase and nitrate reductase are illustrated in Fig. 1. Increasing copper from deficient to toxic levels enhanced the activity of cytochrome *c* oxidase; but this effect was much reduced when molybdenum was increased to toxic levels. A similar result was obtained for cytochrome *c* reductase. The reverse effect is shown by nitrate reductase, a molybdo-flavoprotein[4]; increasing molybdenum from deficiency to sufficiency stimulated its activity whereas copper depressed it.

The results for acid phosphatase and reduced triphosphopyridine nucleotide diaphorase are given in Table 1. The phosphatase was depressed by increasing molybdenum from deficiency to toxicity levels and an increase in copper did not significantly offset it. The reverse effect was found for the diaphorase activity which was inhibited by the highest copper treatment, and this was not significantly overcome by increasing molybdenum. Nitrite reductase was depressed when either copper or molybdenum was in excess. Although the overall effects of the two metals on catalase, peroxidase and alkaline phosphatase or the reduced diphosphopyridine nucleotide diaphorase were not significant, a deficiency of molybdenum depleted the two iron enzymes, as observed previously[6].

It appears that the nutrient antagonisms in nutrition experiments may be related to their effects on certain enzyme systems as illustrated here for copper and molybdenum in *Neurospora*. A full account of this work will appear in the *Journal of General Microbiology*.

Note added in proof. Subsequent experiments have shown that molybdenum competitively inhibits acid phosphatase *in vitro* presumably by forming a molybdo-phosphate addition compound with the substrate. Copper dispersed this complex and restored the enzyme activity to normal. Vanadate or tungstate had a similar inhibitory effect to molybdate on the enzyme activity, which was also reversed by adding copper.

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Radiosensitivity of Salt Uptake in Plants

Some investigations[1] of the effects of radioisotopes absorbed by plants have suggested that the mechanism of salt uptake is sensitive to low doses of ionizing radiations. It is impossible, however, in such experiments to make precise estimates of the dose to which the tissues are exposed. This uncertainty can be overcome by exposing plants to external sources of radiation.

In the experiments reported here, aerated suspensions of *Chlorella pyrenoidosa* (Emerson strain) in 0·005 *M* solutions of rubidium chloride, containing tracer amounts of rubidium-86, were exposed to doses of 50–1,000 r. of 240-kV. X-rays, during a 60-min. period. The *Chlorella* was then separated from the active solution and resuspended in an aerated 0·01 *M* solution of rubidium-85 chloride, and exchange was allowed to continue for 60 min. By this means the rubidium-86 taken up was separated arbitrarily into two fractions: that which was readily exchangeable with rubidium-85, consisting of ions which were freely diffusible or held in Donnan systems and by other exchange mechanisms, and a second fraction which was non-exchangeable under the experimental conditions. This latter fraction would include ions that had undergone active transport. Solutions were counted in an *M*.6 liquid counter. In all experiments there were five treatment replicates and five controls.

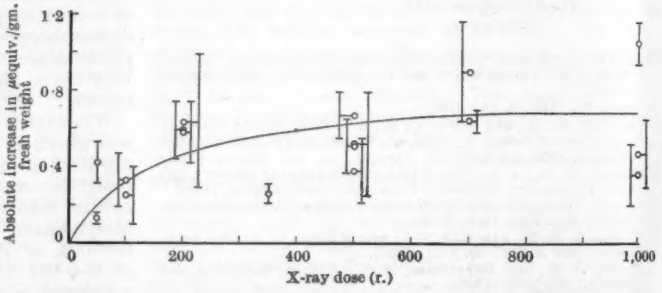

Fig. 1. Depression of non-exchangeable uptake induced by X-irradiation in *Chlorella pyrenoidosa*

At none of the doses used was there any significant effect upon the amount of readily exchangeable ion, but at all dose-levels there was a significant decrease in the amount of non-exchangeable ion as compared with the uptake by the unirradiated controls. In Fig. 1 the absolute decrease in uptake is plotted for the various dose-rates. There was very little increase in the effects of X-rays between 200r. and 1,000r.

It should be noted that the *Chlorella* stocks used in this work could not be grown under absolutely constant conditions; thus the rate of salt uptake by the unirradiated controls varied between experiments. In Table 1 the results for the experiments at 200r. and 500r. shown in Fig. 1 are examined in greater detail. It is seen that although the percentage decrease varied at both dose-levels, the absolute reduction in absorption induced by radiation was relatively constant.

It is suggested that this observation may in part explain the widely varying effects of the radiations from tracers on salt uptake which have been reported hitherto. A full report of this investigation, which is

Table 1. Uptake of Rubidium-86 by Suspensions of *Chlorella*, calculated as Micro-equivalents per gram Fresh-weight

Experiment No.	X-ray dose	Exchangeable		Non-exchangeable		Mean decrease in uptake	
		Irradiated	Control	Irradiated	Control	Decrease (per cent)	Absolute decrease
3	200r.	2·65 ± 0·07	2·69 ± 0·07	1·87 ± 0·17	2·50 ± 0·19	25	0·63
21	200r.	0·73 ± 0·03	0·71 ± 0·014	1·11 ± 0·103	1·70 ± 0·055	35	0·59
16	200r.	0·72 ± 0·04	0·67 ± 0·03	0·47 ± 0·029	1·05 ± 0·13	55	0·58
11	500r.	3·68 ± 0·09	3·74 ± 0·11	1·92 ± 0·09	2·44 ± 0·18	21	0·52
15	500r.	1·02 ± 0·03	0·97 ± 0·04	1·29 ± 0·065	1·80 ± 0·80	28	0·51
1	500r.	1·62 ± 0·17	1·92 ± 0·09	1·02 ± 0·05	1·69 ± 0·07	40	0·67

being extended to include the effects of cobalt-60 gamma rays, will be presented elsewhere.

This work was carried out at the Medical Research Council Radiobiological Research Unit, Harwell. One of us (D. A. B.) was in receipt of a grant in aid from the Agricultural Research Council.

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Occurrence of Motile Gametes in *Prasiola stipitata* Suhr*

The apparent absence of sexual reproduction in the Prasiolaceae has been one of the notable features of this family. It was of considerable interest, therefore, when two decades ago, Yabe[1] announced that sexual reproduction occurs in the freshwater species *Prasiola japonica* Yatabe and is effected by the fusion of anisogamous biflagellated gametes. Fujiyama[2,3], also using material of *P. japonica*, has confirmed Yabe's observations in the main essentials, except that he considers the female gamete to be non-motile. For all that, doubts about the sexual reproduction of *Prasiola* have been expressed quite recently by Fritsch[4] and Smith[5], although Fujiyama's second paper could not have been seen by these authors at the time they wrote.

As a result of observations on the marine species, *P. stipitata* Suhr, we are able to confirm the occurrence of motile anisogamous gametes in this genus. The senior author first distinguished the gametophytes among material collected at Bangor, North Wales, in February 1955; but it was not until February of the following year that she was able to verify the motility and fusion of the gametes. In view of the interest of these observations, a detailed investigation of the development and life-history of this species has since been undertaken by the junior author, who has also studied the gametes and fusion in greater detail.

Gametophytic thalli of *P. stipitata* are common in the winter months and are easily recognized by their conspicuous patchwork appearance (Fig. 1). This is due to mixed darker areas from which female gametes are liberated and much paler areas from which come the male gametes. For every female portion of the thallus there is a corresponding and contiguous male portion. The size of individual areas, and accordingly the number of gametes formed in them, vary greatly in different thalli and even within the same thallus. While the vegetative parts of the thallus are monostromatic, in the gamete-forming portions the thallus is polystromatic, usually four-layered in the female and eight-layered in the male areas. The gametes mature basipetally and are liberated periodically. Both gametes are broadly guttiform and bear, at their pointed anterior end, two isokontan flagella of the whiplash type (Fig. 2*a*, *b*). The flagella of the female gamete are much longer than those of the male.

Immersing dry thalli induces liberation of mature gametes, and fusion follows very soon afterwards. In the instances observed, fusion has been limited to gametes of the same thallus isolated on microscope slides or culture dishes. On the other hand, it would be difficult, without very elaborate technique, to prove fusion between gametes from different thalli. Female gametes usually lose one flagellum before fusion, which begins at the anterior end of the gametes (Fig. 2*c*). Apparently, both flagella of the male gamete are lost at the time of fusion as the zygote has a single flagellum which, on account of its length, must belong to the female gamete. Sometimes the basal remnants of the male flagella can be seen attached to the zygote. After a short period of motility, the pear-shaped zygote (Fig. 2*d*) loses its flagellum and becomes rounded.

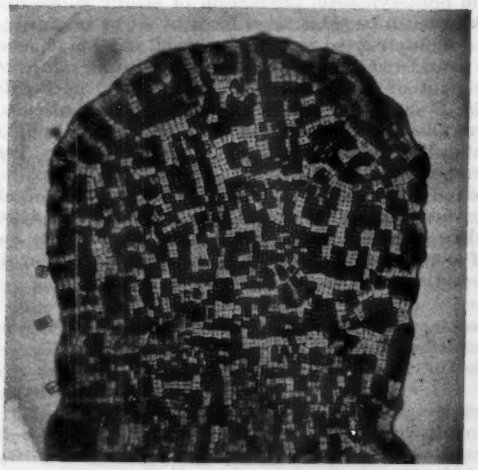

Fig. 1. Upper portion of a gametophytic thallus of *Prasiola stipitata* Suhr, showing darker areas of the female gametes and paler ones of the male gametes. Photographed living. × 90

* Although this specific name may not be the valid one for the species concerned, being in general use, it is retained until certain taxonomic and nomenclatural questions have been settled.

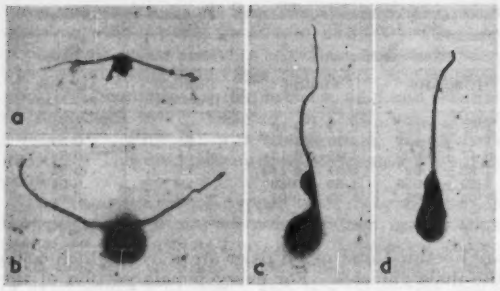

Fig. 2. Gametes and zygotes of *Prasiola stipitata* Suhr. *a*, Male gamete; *b*, female gamete; *c*, gametic fusion; *d*, motile zygote. All photographed after staining by Kirkpatrick's method. × 1,250

The gametes and zygote in Fig. 2 have been fixed in fumes of osmic acid and have been stained by Kirkpatrick's method as modified by Manton[6].

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Flowering of *Xanthium* under Long-Day Conditions

Efforts to induce flowering in the short-day plant *Xanthium pensylvanicum* under long-day conditions have consistently failed up to now. From numerous reports it has been concluded that for flower induction a short photoperiod must be followed by a long night. The role of the short photoperiod seems to be the photosynthetic production of energy substrates, since it can be substituted for it by sugar treatment[1]. An uninterrupted long dark period of 9 hr. or more is considered to be necessary to build up a minimum amount of 'flower stimulus'. However, in *Perilla*, also a short-day plant, the long-night requirement was alleviated by exposing the plants to a low light-intensity during the day[2]. Furthermore, a low-temperature treatment during part of the long photoperiod was found to promote flowering (Wellensiek, private correspondence). Thus it appeared worth while to study the effect of low light-intensity and of low temperature during a long photoperiod on the flowering response in *Xanthium*.

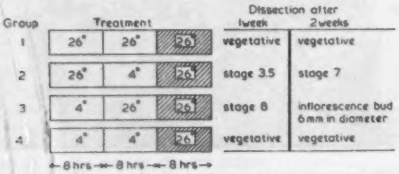

Fig. 1. The influence of different temperatures during the long photoperiod on the flowering response in *Xanthium*

Experiments on the influence of a low light-intensity during a 16-hr. photoperiod on flowering were completely negative. No flowering occurred. *Xanthium* requires a high light-intensity period for its flower induction. In addition, a low light-intensity during the short photoperiod (8 hr.) delayed flowering considerably. From dissection of the terminal buds, it was concluded that this delay was not due to postponed induction but to a slower development of the flower primordia. This again supports the idea that in *Xanthium*, in contrast to *Perilla*, flowering is only possible when a relatively large amount of energy is available. Given this amount of energy, the question remains whether a long-night period is obligatory for flowering or not.

It is known that small amounts of light or a low temperature during the dark period render this period in short-day plants ineffective. A low temperature during the short light-period does not affect flowering very much. But what is the effect of light at low temperature, provided that enough light at high temperature has been given to meet the high light-intensity requirement of *Xanthium*? Does this light prevent flowering, or does it act, in a physiological sense, as darkness?

To investigate this effect, the following experiments were set up in the Earhart Laboratory at Pasadena, California. Plants grown under long-day conditions (light-intensity ± 1,000 f.c.) until they had three or four mature leaves were exposed to a 16-hr. photoperiod, half of which was at 26° C. and half at 4° C.; the dark period (8 hr.) was given at 26° C. In one group the low temperature was given just before the dark period, and in the other just after the dark period (see Fig. 1). The treatment lasted four days, after which the plants were put under normal long-day conditions. Each treatment included twenty plants, half of which were dissected at one week and the other half two weeks after treatment. A suitable measure of rate of growth of inflorescence bud was found to be that developed by Salisbury[3].

The results (see Fig. 1) indicate that: (1) flower initiation under long-day conditions is possible; (2) flower initiation is, qualitatively, not dependent on the time of the low-temperature treatment during the light period; (3) the flowering response is much larger when the low-temperature period precedes the high-temperature period.

In another experiment the same treatments were given, but for two days only. The plants responded in the same way, although less markedly. After two weeks, the terminal buds of group 2 were just starting to become generative (stage 1.8), whereas those of group 3 had already reached stage 6. The controls were completely vegetative.

It is evident from these experiments that for flowering there is no absolute requirement for a 9-hr. dark period in *Xanthium*. More work has still to be done to elucidate the relation between light at low temperature and darkness.

I am indebted to Dr. F. W. Went for his hospitality and co-operation.

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May 16.

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Distribution of Chiasmata in an 'Asynaptic' Locust

THE relationship between the length of the chromosomes and the frequency with which they form chiasmata at meiosis is well known and has been analysed extensively by Darlington[1], Mather[2] and others. In general, it is found that long chromosomes form more chiasmata than short chromosomes in the same nucleus. The chiasma frequency, however, is not always found to be directly proportional to length, that is, the potential for forming chiasmata varies between chromosomes to some degree independently of their length. The details of such variation could be investigated in most favourable circumstances during observations made in *Locusta migratoria*. These are briefly described below.

An exceptional male in one family was found with an abnormally low chiasma frequency at meiosis during which univalents appeared in a high proportion of spermatocytes. This example of asynapsis is, so far as I know, the first recorded for this species. Because the chromosomes can be classified into groups of different lengths the relative frequencies with which they form, or fail to form, chiasmata under these conditions can readily be ascertained for the chromosomes in different groups. In the male locust there are eleven pairs of autosomes and one *X*. The classification and measurements, after Mather[3], are given in Table 1.

Table 1

Chromosome pairs	*L*(2)	*LM*(1)	*M*(5)	*S*(3)
Length in μ	5·3	3·9	2·9	1·2

In the asynaptic and other males in this family there were supernumerary chromosomes in a proportion of the spermatocytes[4]. These had no detectable influence on the chiasma frequency.

The diplotene chiasma frequencies of the asynaptic male are plotted against chromosome-length in the graph. Also plotted, for comparison, are the chiasma frequencies in a normal sib. It will be seen that the response to the abnormal, probably genotypically determined, conditions causing asynapsis is not the same for all classes of chromosomes. The reduction in chiasma frequency is relatively much greater in the *L* and *LM* chromosomes than in the *M* and, in particular, the *S* chromosomes. A further comparison suggests more precisely how the differences between the groups arise. This comparison takes into account the frequencies with which their members completely fail to form chiasmata, that is, produce univalents. The data are given in Table 2.

Table 2. CHIASMA FREQUENCY

	Less than one	One or more
L	12	38
LM	7	18
M	12	113
S	2	73

We see that only exceptionally are the *S* chromosomes unable to form at least one chiasma in the asynaptic male. As the graph (Fig. 1) shows, their average, about 1, is virtually the same in both normal and asynaptic individuals. The longer chromosomes, on the other hand, fail to form one chiasma with a significantly higher frequency ($P = < 0{\cdot}01$). This, as distinct from their forming fewer chiasmata over and above one, accounts for a large part of the reduction in their chiasma frequencies.

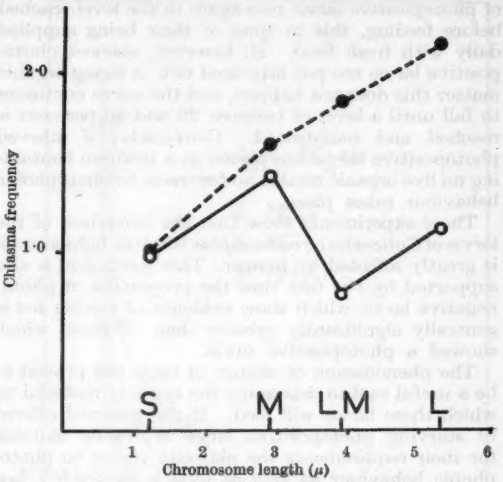

Fig. 1. The chiasma frequencies at diplotene plotted against chromosome-length in an asynaptic and a normal male locust. Data from thirty-five cells in each. Asynaptic, ○; normal, ●

From the earlier results[1,2], based mainly on observations in normal diploids of a number of species, it was concluded that short chromosomes were endowed with special, distinctive, properties in respect of their ability to form at least one chiasma during meiosis. The disproportionately high frequencies with which the longer chromosomes form univalents under the conditions of asynapsis described above confirm this conclusion in a decisive fashion. No doubt, as the earlier authors suggested, the difference between long and short chromosomes is adaptive, securing, in normal circumstances, regular pairing within nuclei the chromosomes of which vary widely in length, and where, as in locust, the average chiasma frequency per bivalent is comparatively low.

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Changes in Response to Light Stimuli of the Larvæ of *Culicoides circumscriptus*

WHEN the larvæ of *Culicoides circumscriptus* are extracted from the mud of their natural habitat the great majority exhibit a negative phototaxis. If they are kept in water without food over a period of time many become positively phototactic. The percentage of larvæ which undergo this reversal increases rapidly for 6–7 days and thereafter remains fairly constant at a level of between 60 and 90 per cent of their total number.

If food is given to the larvæ at this stage there follows a sudden drop in the proportion of photopositive individuals. In some experiments the food given consisted of chopped-up blowfly larvæ, which is not the natural food of the larvæ of this species of *Culicoides* and, after the initial drop, the proportion

of photopositive larvæ rose again to the level reached before feeding, this in spite of their being supplied daily with fresh food. If, however, starved photopositive larvæ are put into mud rich in living organic matter this does not happen, and the curve continues to fall until a level of between 20 and 30 per cent is reached and maintained. Conversely, if starved photopositive larvæ are placed in a medium containing no live organic matter no reversion to photophobic behaviour takes place.

These experiments show that the behaviour of the larvæ of *Culicoides circumscriptus* towards light stimuli is greatly affected by hunger. This conclusion is also supported by the fact that the proportion of photonegative larvæ which show evidence of having fed is generally significantly greater than of those which showed a photopositive taxis.

The phenomenon of change of taxis has proved to be a useful tool to determine the types of material on which these larvæ will feed. If the material offered to starving photopositive larvæ is wholly suitable for their requirements the majority revert to photophobic behaviour as long as food is available; but if the food is inedible or non-nutritious there is no change of taxis. If the food is edible but inadequate for nutritional requirements the larvæ exhibit only a temporary reversion to negative phototaxis.

It is possible that this method of determining food requirements may be applied to a number of different animals but much depends on the habits and environment of the species concerned. In *C. maritimus*, a species living in the same habitat as *C. circumscriptus* but in a different niche and with apparently different feeding habits, the changes in response to light stimuli are not sufficiently clearly defined for this method to be used.

The above experiments will be more fully described and their significance discussed in a paper to be published in the near future.

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Feeding Habits of a Marine Centipede

During a night collecting expedition on the shore at Port Erin, Isle of Man, a party of students, accompanied by Dr. Iles and myself, came across a rather unusual association of predator and prey. The predator was the common littoral geophilomorph, *Scolioplanes maritimus* (Leach), and its food consisted of barnacles (*Balanus balanoides* (Linné)) and periwinkles (*Littorina saxatilis* (Olivi)).

The centipede is common all around the British coast; but a particularly thriving colony has been under observation at Port Erin for several years. The animals inhabit coarse shale between mid-tide level and high-water mark during the hours of daylight; but at night they are to be seen on an adjacent rock face and concrete wall with barnacles on the face and periwinkles in the cracks and fissures.

On the first occasion, at about 10 p.m., the hind-ends of three centipedes were seen projecting from between the opercular plates of an apparently intact barnacle. The animals did not react to the light of a torch but rapidly extricated themselves when touched. The slit between the opercular plates was apparently just sufficiently wide to allow the strap-shaped centipedes to enter or leave. The soft parts of the barnacles had been reduced to a slimy consistency suggesting extra-intestinal digestion.

On the first night two barnacles were seen, each providing a meal for three centipedes. This was an hour or two before high tide. Later in the week, with the advancing time of high tide, we were able to keep the animals under observation as the tide receded from the area, for several nights, all of which were moonlit. As many as twelve centipedes were seen feeding in an area roughly two square metres on the concrete wall and many others on the rock face, where counting was more difficult, the animals being disturbed more easily by movement of seaweed, etc. Adults of both sexes, together with immature stadia, were involved. Progressively later visits on the same night revealed a higher proportion of animals feeding as opposed to just walking around and a greater aggregation of the feeding animals—the maximum number observed on any one barnacle being six.

On fewer occasions, centipedes were seen feeding on *Littorina saxatilis*. One centipede had its head completely hidden in a periwinkle which had become dislodged from the wall and was swinging pendulum-fashion on the end of the centipede. The centipede was anchored to the wall by no more than four or five of its hindermost pairs of legs.

No centipede was caught in the act of making the initial entry into either a barnacle or a periwinkle, since the torchlight caused the animals to move rapidly away from the illuminated area. At first sight, the business of entering the prey would appear hazardous in the extreme; do the centipedes immobilize the closing mechanisms of their prey by means of the poison claws or is the closure not sufficiently tight to do them harm? The size of aperture through which a geophilomorph can pass is amazingly small, and we noticed that a small gap always exists between the plates of the barnacle, which latter only close tightly on strong mechanical stimulation. The periwinkles are not closed at night, of course, but are actively feeding.

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Surface Properties of Sodium Octyl Sulphate in Saturated Salt Solutions

As part of a study of the flotation of soluble salts the surface tension of sodium octyl sulphate has been measured[1] in saturated solutions of lithium, sodium, potassium and ammonium chlorides at 20° C. No previous measurements are recorded for the surface tension of sodium octyl sulphate in saturated salt solutions or in water. This compound has very little effect on the surface tension in water, but in the saturated salt solutions the maximum lowering of surface tension is approximately 50 dynes cm.$^{-1}$.

The measurements were made by the drop-volume technique and the surface tension calculated by applying the corrections of Harkins and Brown[2]. For temperature control the 'Agla' syringe was

enclosed in a thermostated jacket and the whole assembly placed in a water bath (unpublished work by H. C. Parreira). The sodium octyl sulphate was tested for purity by paper chromatography and found free from higher homologues. The chlorides were of analytical reagent quality, except the lithium chloride. Solutions of sodium octyl sulphate were prepared in two ways to ensure that equilibrium was obtained. Either known weights of crystals of octyl sulphate were shaken with measured volumes of saturated salt solution at 20° C., or the required amount of salt, freshly dried at 110° C., was weighed into a standard flask to which distilled water and aliquots of a 10^{-2} molar aqueous solution of octyl sulphate were added.

In the saturated salt solutions no changes of surface tension with time were found. In water ageing effects[2] are important, but have been shown to disappear if salt is added[4]. Possible effects of small amounts of calcium and barium[5] were investigated by adding to (analytical reagent) ammonium chloride 0·005 per cent Ba^{2+} as barium chloride and 0·01 per cent Ca^{2+} as calcium chloride. No effect was found. Experiments with (analytical reagent) sodium chloride purified by double precipitation did not show any differences from the surface tensions obtained with unpurified salt.

In Fig. 1 the surface pressures are plotted against the logarithm of the concentration of sodium octyl sulphate in saturated sodium, potassium and ammonium chloride solutions. Lithium chloride is so soluble that in saturated solution the sodium octyl sulphate did not dissolve. In Fig. 2 the area occupied by the octyl sulphate molecules is plotted as a function of surface pressure. The areas were calculated from the equation[6] $d\pi = RT\Gamma \, d \ln c$, where π is surface pressure, Γ the surface excess concentration, and c is the bulk concentration of sodium octyl sulphate.

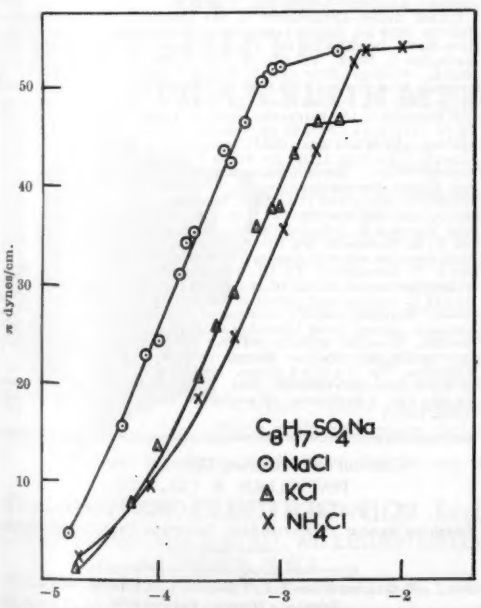

Fig. 1

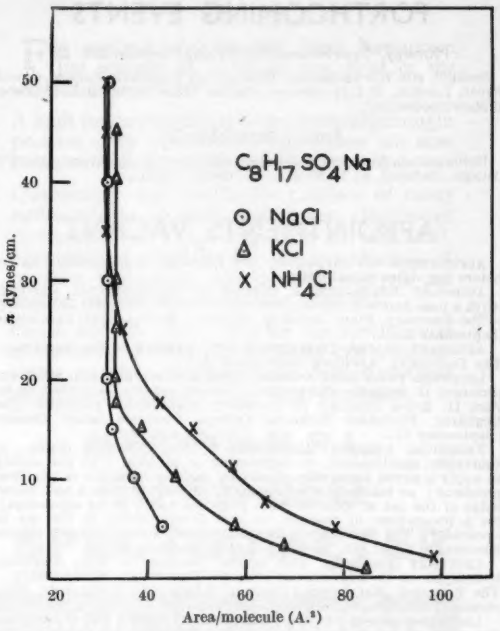

Fig. 2

Fig. 2 shows that the expansion of the octyl sulphate film is related to the size of the anhydrous counter-ion in the solution. The radii of ammonium, potassium and sodium ions are 1·43, 1·33 and 0·95 A. respectively. The film is most expanded for ammonium chloride and least in sodium chloride. The curves are not related to the solubility, or activity, of the inorganic salts. The correlation of area per molecule with ionic size of the counter ion has been noted[7] for insoluble films of octadecyl sulphate on solutions of lithium, sodium, potassium and ammonium chlorides of equal activity (6·7). However, for the insoluble films the radii of the hydrated ions is significant so that expansion of the film decreased from lithium chloride in the order sodium, ammonium and potassium chloride.

We are indebted to Dr. J. H. Schulman for stimulating discussion and interest in this work, which was made possible by grants from the Consolidated Zinc Corporation, Ltd., and the Ernest Oppenheimer Endowment.

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FORTHCOMING EVENTS

Monday, September 16—Friday, September 20

Society for Experimental Biology (at University College, Gower Street, London, W.C.1)—Symposium on "The Biological Replication of Macromolecules".

Friday, September 20

Biochemical Society (in the Department of Biochemistry, Queen's College, Dundee), at 10.30 a.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Experimental Officer or Experimental Officer (with a pass degree in science) for work in the Biochemical Laboratory—The Secretary, Plant Breeding Institute, Trumpington, Cambridge (September 20).

Assistant in the Department of Chemistry—The Secretary, The University, Aberdeen (September 20).

Lecturer (with good academic qualifications and industrial experience) in Organic Chemistry, to teach organic chemistry up to Part II, Royal Institute of Chemistry examination standard—The Registrar, Flintshire Technical College, Connah's Quay, Chester (September 21).

Technical Assistant (preferably with a university degree, or equivalent qualification, in engineering or physics, with the ability to apply a sound knowledge of physics and mathematics to practical problems; an interest in instrumentation and electronics and knowledge of the use of tools for such purposes would be an advantage), for a programme of research on new developments in the use of electricity—The Secretary (Establishments Section), South Wales Electricity Board, St. Mellons, Cardiff (September 24).

Lecturer (preferably with special interests in high frequency techniques or in servomechanisms) in Electrical Engineering—The Principal, Manchester College of Science and Technology, Manchester 1 (September 30).

Lecturer (able to carry out independent research and to supervise the work of postgraduate students) in Theoretical Physics—The Registrar (Room 9 O.R.B.), The University, Reading (September 30).

Principal (with a university degree in science or engineering, or equivalent qualification, and experience in responsible posts in technical education) of Belize Technical College, British Honduras, for duties including advising the Government on technical education—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.114/31/04 (October 4).

Assistant Lecturer or Lecturer (with a degree in pure science) in Agricultural Zoology at the Canterbury Agricultural College, New Zealand, to teach pure and applied zoology for the degree and diploma courses in agriculture and horticulture, and to carry out research in agricultural zoology—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 15).

Lecturer or Assistant Lecturer in Mathematics at the University of Otago, Dunedin, New Zealand—Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 15).

Lecturer (with an honours degree in mathematics) in Mathematics in the Department of External Studies, University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 18).

Lecturer (preferably graduate in agricultured science or civil engineering, with experience in soil genesis or plant nutrition or mechanical properties of soils) in Agriculture (Soil Science) at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 19).

Analyst, Scientific Officer or Senior Scientific Officer grade (with a first- or second-class honours degree and suitable analytical experience), for the British West Indies Sugar Research Scheme, Imperial College of Tropical Agriculture, Trinidad, for work mainly on devising new analytical techniques over a wide field—The Secretary, The Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (October 31).

Keeper and Lecturer in Anthropology, joint appointment, at the Otago Museum and University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Demonstrator (some experience essential and preferably with L.I.M. qualification) in the Materials and Metallurgy Section, to assist in the supervision of laboratories for metallography, heat treatment and testing of steels and light alloys—The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks.

Demonstrator in Pharmacy—The Registrar, The University, Nottingham.

Lecturer or Assistant Lecturer in Psychology, to be responsible for the course in physiological psychology—The Registrar, The University, Hull.

Lecturers and Assistant Lecturers in Engineering in the Departments of Civil, Mechanical, Electrical and Mining Engineering—The Registrar, The University, Nottingham.

Mathematician (male or female, with a university degree and preferably with some experience in statistics) to assist with a programme of research in the field of naval architecture—The British Shipbuilding Research Association, 5 Chesterfield Gardens, Curzon Street, London, W.1.

Physicist/Metallurgist (with a good engineering or science degree, or equivalent qualification) in the Materials and Metallurgy Section, to lead a research project on the fatigue properties of light alloys—The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks.

Research Assistant (preferably with a good engineering qualification and some laboratory and workshop experience) in the Materials and Metallurgy Section, for work associated with the fatigue of light alloys—The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks.

Scientific Officer (with an honours degree in physics or mathematics, preferably with postgraduate course in meteorology and at least one year's postgraduate experience) at the Royal Observatory, Hong Kong, for general scientific duties, including independent forecasting—Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.57/51/03.

Senior Lecturer in Animal Husbandry at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

Senior Lecturer (with M.Sc. degree, at least five years experience of teaching and laboratory work in a British university, also with experience of high voltage practice) in Electrical Engineering, at the University of Rangoon, Burma, to teach electrical engineering up to degree standard, also to set up high voltage and electric machines laboratories—The Ministry of Labour and National Service (E.9), Almack House, King Street, London, S.W.1, quoting A.12/BUR/TCS/88.

Senior Research Assistant (with postgraduate experience in the mechanics of solids, particularly elasticity) in the Department of Mining Engineering, to work on the theoretical analysis of ground movements in mining, under the supervision of the Professor of Applied Mathematics—The Registrar, The University, Nottingham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Admiralty Bulletin No. 91: High-Speed Photography in Naval Research. By W. Deryck Chesterman. Pp. 9. (London: Admiralty, 1957.) [117

Coal Tar Research Association. Review of Coal Tar Technology, July–December 1956. (Vol. 8, Part 2.) Pp. ii+83–168. (Gomersal, Leeds: Coal Tar Research Association, 1957.) 7s. 6d. [117

Computers and Steel. By D. G. Owen. Pp. 24. (London: British Iron and Steel Research Association, 1957.) [117

Other Countries

University of California Publications in Botany. Vol. 28, No. 6. Studies of Spontaneous Chromosome Breakage in Interspecific Hybrids of Bromus By Marta Sherman Walters. Pp. 335–447+plates 41–61. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1957.) 2 dollars. [107

Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin. Klasse für Chemie, Geologie und Biologie. Jahrgang 1955, Nr. 10: Beiträge zur Tektonik des Thüringer Beckens—2. Pp. 85. (Berlin: Akademie-Verlag, 1957.) 29 D.M. [107

United States Department of the Interior: Geological Survey. Bulletin 1019-F: Selected Annotated Bibliography of Thorium and Rare-Earth Deposits in the United States, including Alaska. By Katharine L. Buck. Pp. iii+517–541+plate 3. 40 cents. Bulletin 1021-K: Geology of the Atomic Energy Commission Nevada Proving Grounds Area, Nevada. By Mike S. Johnson and Donald E. Hibbard. Pp. iv+333–384+plates 32 and 33. 1 dollar. Bulletin 1024-I: Tungsten Deposits in the Fairbanks District, Alaska. By F. M. Byers, Jr. Pp. iv+179–216+plates 23–28. 1 dollar. Bulletin 1029-A: Annotated Bibliography of the Analytical Chemistry of Niobium and Tantalum, January 1935–June 1953. By Frank Cuttitta. Pp. iii+73. 25 cents. Bulletin 1030-I: Reconnaissance Study of Uranium Deposits in the Red Desert, Sweetwater County, Wyoming. By Donald G. Wyant, William N. Sharp and Douglas M. Sheridan. Pp. iv+237–308+plates 16–23, n.p. Bulletin 1031-K: Uranium Deposits in Oolitic Limestone near Mayoworth, Johnson County, Wyoming. By R. R. Guilinger and P. K. Theobald. Pp. iii+335–342. 15 cents. Bulletin 1036-J: Field Determination of Uranium in Natural Waters. By F. N. Ward and A. P. Marranzino. Pp. iii+181–192. 15 cents. Bulletin 1042-I: A Reconnaissance Study of the Beach Sands of Puerto Rico. By Robert B. Guillou and Jewell J. Glass. Pp. iii+305+plate 15. 60 cents. Bulletin 1042-F: Zoning of the Bitter Creek Vanadium-Uranium Deposit near Uravan, Colorado. By Allen V. Heyl. Pp. iii+201. 15 cents. Bulletin 1047-A: Coal Geology of the White Oak Quadrangle, Magoffin and Morgan Counties, Kentucky. By W. L. Adkinson. Pp. iv+23+4 plates. n.p. Bulletin 1054: Bibliography of North American Geology, 1954. By Ruth Reece King and others. Pp. iii+484. 1.50 dollars. (Washington, D.C.: Government Printing Office, 1957.) [107

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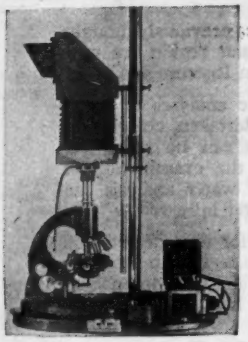

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